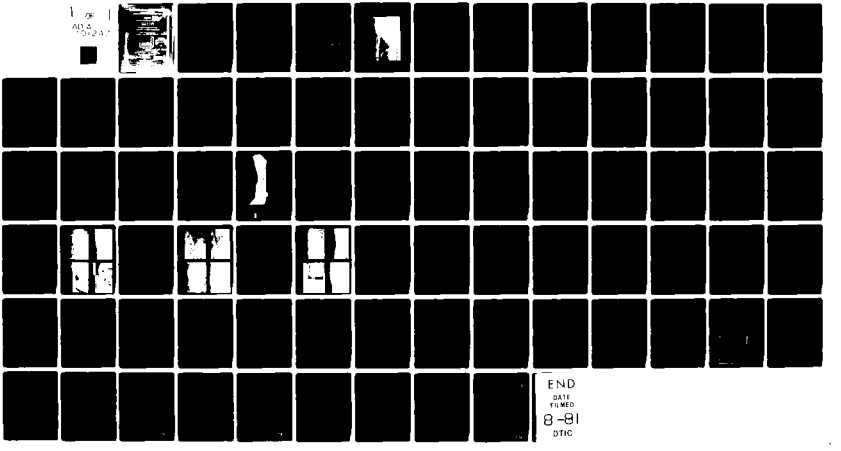
AD-A101 247 GAI CONSULTANTS INC MONROEVILLE PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. POCONO WOODLAND LAKE DAM (NDI --ETC(U)
JUN 81 B M MIHALCIN DACW31-81-C-0015
UNCLASSIFIED NL



END
DATE FILMED
8-81
DTIC

National Dam Inspection Program. Pocono Woodland Lake Dam (NDI I.D. Number PA-ØØ443, PennDER I.D. Number 52-179), Delaware River Basin, Branch of Raymondskill Creek, Pike County, Pennsylvania. Phase I Inspection Report,

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the Spillway Design Flood is based on the estimated Probable Maximum Flood (greatest reasonably possible storm runoff) for the region, or fractions thereof. The Spillway Design Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

Breach analyses are performed, when necessary, to provide data to assess the potential for downstream damage and possible loss of life. The results are based on specific theoretical scenarios peculiar to the analysis of a particular dam and are not applicable to other related studies such as those conducted under the Federal Flood Insurance Program.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ABSTRACT

Pocono Woodland Lake Dam: NDI I.D. No. PA-00443

Owner:	Pocono Woodland Lake Property Owners Association
State Location:	Pennsylvania (PennDER I.D. No. 52-179)
County Located	Pike
Stream:	Branch of Raymondskill Creek
Inspection Date:	12 November 1980
Inspection Team:	GAI Consultants, Inc. 570 Beatty Road Monroeville, Pennsylvania 15146

Based on the visual inspection, operational history, and available engineering data, the dam and its appurtenances are considered to be in excellent condition.

The size classification of the facility is small and the hazard classification is high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the lower bounds of the small category, the SDF is considered to be the 1/2 PMF. Results of hydrologic and hydraulic analysis indicate that the facility is capable of accommodating about 76 percent of the PMF prior to embankment overtopping. As a result, the spillway is deemed adequate.

It is recommended that the owner:

a. Reshape the area immediately downstream of the south embankment to facilitate drainage of surface water into the existing diversion ditch.

b. Remove debris which is partially blocking the emergency spillway approach channel.

c. Develop formal manuals of operation and maintenance to ensure the continued proper care of the facility. In addition, a formal warning system should be implemented that provides for notification of downstream residents should hazardous embankment

conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy preciptation.

GAI Consultants, Inc.

Bernard M. Mihalcin

Bernard M. Mihalcin, P.E.

Date 3 JUNE 1981

Approved by:

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date 19 JUNE 1981

OVERVIEW PHOTOGRAPH

TABLE OF CONTENTS

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
POCONO WOODLAND LAKE DAM
NDI# PA-00443 PENNDER# 52-179

SECTION I
GENERAL INFORMATION

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Pocono Woodland Lake Dam is an S-shaped earth embankment approximately 13 feet high and 1,000 feet long, including spillway. The facility is provided with an uncontrolled, trapezoidal shaped, rock lined spillway with a 12-inch wide concrete weir wall, located approximately 50 feet from the junction of the south and east embankment sections. The outlet works consists of an 18-inch diameter reinforced concrete pipe that discharges at the downstream embankment toe. Flow through the conduit is manually controlled by means of an 18-inch diameter sluice gate located at the inlet. The outlet works riser also functions as a drop inlet. It was designed primarily to provide pool level control during construction and to support the control gate stem. It was not, however, designed as a service spillway.

b. Location. Pocono Woodland Lake Dam is located on a branch of Raymondskill Creek in Dingman Township, Pike County, Pennsylvania. The facility is approximately seven miles west of Milford, Pennsylvania. The dam, reservoir and watershed are contained within the Edgemere, Pennsylvania 7.5 minute U.S.G.S. topographic quadrangle (see Figure 1, Appendix E). The coordinates of the dam are N41° 18.5' and W74° 53.5'.

c. Size Classification. Small (13 feet high, 279 acre-feet storage capacity at top of dam).

d. Hazard Classification. High (see Section 3.1.e).

e. Ownership. Pocono Woodland Lake
Property Owners Association
Box C
Milford, Pennsylvania 18337
Attn: Mr. John T. Stieh, Attorney
P. O. Box 536
Milford, Pennsylvania 18337

f. Purpose. Recreation.

g. Historical Data. Detailed correspondence contained in PennDER files indicates that Pocono Woodland Lake Dam was designed in 1975 by Fred C. Schoenagel, Jr., a registered professional engineer from Greentown, Pennsylvania. Construction did not proceed until early 1977, due to proposed revisions which included a plan to dredge the proposed lake bottom, and legal action from the downstream residents. Construction of the facility was completed in the fall of 1977 and a permit to maintain an existing dam was issued to the present owners by PennDER in April of 1978.

Except for an apparent problem with water quality, the facility has functioned satisfactorily since its completion.

1.3 Pertinent Data.

a. Drainage Area (square miles). 0.32

b. Discharge at Dam Site.

Discharge Capacity of the Outlet Conduit - Discharge curves are not available.

Discharge Capacity of Spillway at Maximum Pool ≈ 480 cfs (see Appendix D, Sheet 7).

c. Elevations (feet above mean sea level). The following elevations were obtained from available drawings and through field measurements based on the elevation of the spillway crest at 1216.0 feet.

Top of Dam	1219.0 (design). 1218.8 (field).
Maximum Design Pool	Not known.
Maximum Pool of Record	Not known.
Normal Pool	1216.0
Spillway Crest	1216.0 (assumed datum).
Upstream Inlet Invert	1206.8 (design).
Downstream Outlet Invert	1206.4 (design). 1206.3 (field).
Maximum Tailwater	Not known.

d. Reservoir Length (feet).

Top of Dam	3150
Normal Pool	2900

e. Storage (acre-feet).

Top of Dam	279
Normal Pool	160

f. Reservoir Surface (acres).

Top of Dam	46
Normal Pool	39

g. Dam.

Type	Homogeneous earth.
Length	959 feet (excluding spillway).
Height	13 feet (field measured; embankment crest to downstream embankment toe).
Top Width	12 feet (design). 17 feet (field).
Upstream Slope	2.5H:1V (design). 3H:1V (field).
Downstream Slope	2H:1V (design). 3H:1V (field).
Zoning	Homogeneous earth (see Figure 4).
Impervious Core	None.
Cutoff	As-built drawings show a 3-foot deep, 10-foot wide cutoff trench along the embankment centerline.
Grout Curtain	None indicated.

h. Diversion Canal and Regulating Tunnels. None.

i. Spillway.

Type	Uncontrolled, trapezoidal shaped channel with a 12-inch wide, concrete weir wall located approximately 50 feet from the junction of the south and east embankments.
Crest Elevation	1216.0 feet.
Crest Length	30-foot bottom width; 41-foot top width.

j. Outlet Conduit.

Type	18-inch diameter, reinforced concrete pipe.
Length	Approximately 80 feet from inlet to outlet.
Closure and Regulating Facilities	Manually controlled at the inlet by means of an 18-inch diameter sluice gate. Gate housed near the base of the concrete riser situated along the upstream embankment face. Riser consists of a five foot square, reinforced concrete drop inlet that discharges through an 18-inch diameter horizontal outlet conduit.
Access	The riser is accessible by boat only.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Design Data Availability and Sources. No formal design reports are available. Information pertaining to the design of the present facility is contained in PennDER files, along with as-built drawings obtained from the design engineer, Fred C. Schoenagel, Jr., P.E., of Greentown, Pennsylvania. Mr. Schoenagel also has calculations pertaining to the design of the emergency spillway. In addition, PennDER files contain a state issued permit application report dated April 14, 1978 which gives a brief description of the various design aspects of the facility.

b. Design Features.

1. Embankment. Details of the basic embankment design are presented in Figures 2, 3 and 4. Information contained on the drawings indicates the embankment is a homogeneous, compacted earth fill with a maximum height of approximately 13 feet. A three foot deep cutoff trench was provided in the foundation along the embankment centerline. The embankment crest is shown to be 12 feet wide with a 2.5H:1V upstream slope and 2H:1V downstream slope (field measurements indicated that the embankment crest is actually 17 feet wide while the upstream and downstream slopes are set at 3H:1V). Approximately 12 inches of well graded riprap overlying a six inch gravel filter is provided on the entire upstream embankment face. The downstream embankment face and other exposed areas are seeded and well covered.

2. Appurtenant Structures.

a) Spillway. Design features of the spillway are presented in Figures 3 and 4. As indicated, the spillway consists of an uncontrolled, trapezoidal shaped channel with a 12-inch wide, concrete weir wall. The channel measures 30 feet across the bottom and 41 feet across the top at the weir. The spillway sidewalls are keyed into the embankment a distance of five feet on both sides. The spillway discharges into a rock lined, trapezoidal shaped channel that parallels the embankment for a distance of 200 feet prior to merging with the outlet conduit discharge channel. The entire channel is riprap lined with well graded stones.

b) Outlet Conduit. Design features of the outlet conduit are presented in Figures 3 and 4. The outlet conduit consists of an 18-inch diameter, reinforced concrete pipe. PennDER records indicate that the conduit has been placed on a concrete cradle and three anti-seep collars have been provided. Flow

through the conduit is controlled by means of an 18-inch diameter sluice gate located at the inlet. The gate is manually operated from atop a concrete riser structure. The riser is located on the upstream embankment face, approximately 200 feet to the left of the spillway. A concrete headwall has been provided at the discharge end of the conduit.

c. Specific Design Data and Criteria.

1. Embankment. No design data or information relative to embankment design procedures are available. The design engineer indicated that the embankment material consists of nonorganic, glacial till excavated from within the reservoir area.

2. Appurtenant Structures.

a) Spillway. Limited spillway design data is available from the state issued construction permit application report and as-built drawings. Discussions with the designer indicated that the spillway was sized to accommodate state requirements at the time of construction as established by the Pennsylvania "C" Curve.

b) Outlet Conduit. No design data, other than as-built drawings, are available concerning the intake riser and outlet conduit. Discussions with the design engineer indicated that the riser was intended primarily to provide flow control during construction and was not intended to function as a service spillway.

2.2 Construction Records.

PennDER files contain photographs and correspondence accumulated during construction of the present facility; however, there is no information pertaining to specific construction aspects or techniques such as compaction procedures.

2.3 Operational Records.

No pool level, rainfall, or spillway discharge records are available for the facility.

2.4 Other Investigations.

No formal investigations have been conducted since completion of the facility.

2.5 Evaluation.

The available data, coupled with the information obtained during the visual inspection, are considered adequate to make a reasonable Phase I assessment of the facility.

SECTION 3

VISUAL INSPECTION

3.1 Observations.

a. General. Observations made during the visual inspection suggest that the dam and its appurtenances are in excellent condition.

b. Embankment. The visual inspection indicated that the embankment is in excellent condition and well maintained (see Photographs 1 and 4). No seepage through the downstream embankment face was noted during the field inspection; however, standing water near the downstream toe of the south embankment was observed. This condition is not considered serious, but, the area should be reshaped to facilitate drainage of the surface water into the existing diversion ditch.

c. Appurtenant Structures.

1. Spillway. The visual inspection of the spillway revealed that the structure is in good condition (see Photographs 9, 10 and 11). No signs of any concrete deterioration were observed at the time of inspection. The driftwood which is partially blocking the spillway approach channel should be removed, as the spillway channel should be kept clear at all times.

2. Outlet Conduit. Visible aspects of the outlet structure were found to be in good condition. The riser structure on the upstream embankment face was partially submerged (see Photograph 5), as was the outlet conduit at its downstream end (see Photograph 6). The riser structure was not accessible by foot and the gate control was not operated during the inspection. The owner's representative stated that the sluice gate is operable, as the flow out of the lake is regulated in accordance with their operating permit.

The spillway channel and outlet discharge channel are adequately protected by riprap at and downstream of their confluence (see Photographs 7 and 8).

d. Reservoir Area. The general area surrounding the reservoir is characterized by gentle to moderate slopes. The area immediately around the lake has been cleared, but the surrounding area is primarily forested (see Photograph 12).

e. Downstream Channel. Discharges from Pocono Woodland Lake Dam are channeled into an unnamed stream (branch of Raymondskill Creek) which flows south through a steep valley with steep confining slopes. Within 2,200 feet from the dam the stream passes beneath a local road and then converges with Raymondskill Creek.

Raymondskill Creek flows in a southeasterly direction for approximately one mile before discharging into Lake Netimus. A farm house and associated structures are located immediately downstream of Lake Netimus Dam (height ≅ 20 feet, storage capacity ≅ 52 acre-feet). Raymondskill Creek then flows eastward for approximately one mile before discharging into Beaver Lake. Within this reach, a small commercial office building and two houses are situated along the banks of Raymondskill Creek. Thus, it is estimated that as many as ten persons could be affected as a result of a breach of Pocono Woodland Lake Dam. Consequently, the hazard classification is considered to be high.

3.2 Evaluation.

The overall condition of the facility is considered to be excellent. An area near the downstream toe of the south embankment where minor ponding occurs should be regraded to facilitate drainage into the existing diversion ditch. Driftwood accumulated in the spillway approach channel should be removed and the spillway kept clear at all times.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedure.

The facility is essentially self-regulating. That is, excess inflows discharge automatically through the spillway and are directed downstream. The owner's representative stated that the outlet conduit is partially open to provide flow required by the operating permit. No formal operations manual is available.

4.2 Maintenance of Dam.

No formal maintenance program exists at this facility. The Pocono Woodland Lake Property Owners Association performs maintenance on an unscheduled basis. No formal maintenance manual is available; however, the facility is visited by maintenance personnel on a weekly basis.

4.3 Maintenance of Operating Facilities.

No regular maintenance is reportedly performed on the outlet conduit or its operating equipment.

4.4 Warning System.

No formal warning system is presently in effect.

4.5 Evaluation.

No formal operations or maintenance manuals are available, but are recommended to ensure the proper future care of the facility. In addition, a formal warning system should be developed and incorporated into any such manuals.

SECTION 5

HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No formal design reports are available. A state issued permit application report, dated 1978, indicates that the spillway was designed with a discharge capacity of about 550 cfs, a value which exceeded state requirements as established by the Pennsylvania C Curve (465 cfs for a 200-acre drainage area). The design engineer indicated that the spillway was sized using the basic Manning equation.

5.2 Experience Data.

No formal records of reservoir levels are available. Weekly records of outflow from the facility were reportedly recorded for about a year following the completion of the project, but are no longer available.

5.3 Visual Observations.

On the date of inspection, no conditions were observed that would indicate the spillway could not perform satisfactorily during a flood event, within the limits of its design capacity.

5.4 Method of Analysis.

The facility has been analyzed in accordance with the procedures and guidelines established by the U.S. Army, Corps of Engineers, Baltimore District, for Phase I hydrologic and hydraulic evaluations. The analysis has been performed utilizing a modified version of the HEC-1 program developed by the U.S. Army, Corps of Engineers, Hydrologic Engineering Center, Davis, California. Analytical capabilities of the program are briefly outlined in the preface contained in Appendix D.

5.5 Summary of Analysis.

a. Spillway Design Flood (SDF). In accordance with procedures and guidelines contained in the National Guidelines for Safety Inspection of Dams for Phase I Investigations, the Spillway Design Flood (SDF) for Pocono Woodland Lake Dam ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. This classification is based on the relative size of the dam (small) and the potential hazard of dam failure to downstream developments (high). Since the facility is classified near the lower bounds of the small category, the SDF for the facility is considered to be the 1/2 PMF.

b. Results of Analysis. Pocono Woodland Lake Dam was evaluated under near normal operating conditions. That is, the reservoir was initially at its normal pool or spillway elevation of 1216.0 feet, with the spillway discharging freely. The outlet conduit was assumed to be non-functional for the purpose of analysis. The flow capacity of the conduit is not such that it would significantly increase the total discharge capabilities of the facility. The spillway consists of an uncontrolled, trapezoidal shaped channel with a 12-inch wide, concrete control weir. All pertinent engineering calculations relative to the evaluation of Pocono Woodland Lake Dam are provided in Appendix D.

Overtopping analysis (using the modified HEC-1 computer program) indicated that the discharge/storage capacity of Pocono Woodland Lake Dam can accommodate storms in excess of the 1/2 PMF (SDF), or about 76 percent of the PMF, prior to embankment overtopping. The peak 1/2 PMF inflow of approximately 500 cfs was attenuated by the discharge/storage capabilities of the dam and reservoir, such that the resulting peak outflow was about 280 cfs. The maximum water surface elevation in the reservoir under 1/2 PMF conditions was about 1218.0 feet, or 0.8-foot below the top of the dam (Summary Input/Output Sheets, Sheets B and C).

5.6 Spillway Adequacy.

Pocono Woodland Lake Dam was found to be capable of accommodating storms in excess of its SDF (the 1/2 PMF), and therefore, its spillway is considered to be adequate.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment appears to be in excellent condition. No signs of slope distress or seepage through the downstream embankment face were observed and only minor settlement (about two inches) was measured across the embankment crest. Some ponding of surface water was observed near the toe of the south embankment. The area should be reshaped to facilitate drainage of the surface water into the existing diversion ditch.

b. Appurtenent Structures.

1. Spillway. The spillway is in good condition. Driftwood is partially blocking the approach channel and should be removed.

2. Outlet Conduit. The outlet conduit is in good condition. Although the sluice gate was not operated in the presence of the field team, it was reported by the owner's representative to be functional.

6.2 Design and Construction Techniques.

No design or construction records are available with the exception of a set of as-built drawings supplied by the design engineer. The dam was constructed by G. H. Litz and Sons, Inc., of East Stroudsburg, Pennsylvania.

6.3 Past Performance.

No formal records of past performance are available from the owner or PennDER. Visual inspection showed no evidence of inadequate past performance.

6.4 Seismic Stability.

The dam is located in Seismic Zone No. 1 and it is thought that the static stability of the structure is sufficient to withstand minor earthquake induced dynamic forces. However, no investigations or calculations were performed to confirm this belief.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The results of this investigation indicate the facility is in excellent condition.

The size classification of the facility is small and the hazard classification is high. In accordance with the recommended guidelines, the Spillway Design Flood (SDF) ranges between the 1/2 PMF (Probable Maximum Flood) and the PMF. Since the facility is classified near the lower bounds of the small category, the SDF is considered to be the 1/2 PMF. Results of hydrologic and hydraulic analysis indicate that the facility is capable of accommodating about 76 percent of the PMF prior to embankment overtopping. As a result, the spillway is deemed adequate.

Deficiencies associated with the facility are minor and include: 1) ponding of surface water near the downstream toe of the south embankment; and 2) accumulation of driftwood in the spillway approach channel.

b. Adequacy of Information. The available information is considered adequate to make a reasonable Phase I assessment of the facility.

c. Urgency. The recommendations listed below should be implemented as soon as practical.

d. Necessity for Additional Investigation. No additional investigations are considered necessary at this time.

7.2 Recommendations/Remedial Measures.

It is recommended that the owner:

a. Reshape the area near the downstream toe of the south embankment to facilitate drainage of the surface water into the existing diversion ditch.

b. Remove the accumulated driftwood from the spillway approach channel and keep it clear at all times.

c. Develop formal manuals of operation and maintenance to ensure the continued proper care of the facility. In addition, a formal warning system should be implemented that provides for notification of downstream residents should hazardous embankment conditions develop. Included in the plan should be provisions for around-the-clock surveillance of the facility during periods of unusually heavy precipitation.

APPENDIX A

VISUAL INSPECTION CHECKLIST AND FIELD SKETCHES

CHECK LIST
VISUAL INSPECTION
PHASE 1

NAME OF DAM Pocono Woodland Lake Dam STATE Pennsylvania COUNTY Pike

NDI # PA — 00443 PENNDER # 52-179

TYPE OF DAM Earth SIZE Small HAZARD CATEGORY High

DATE(S) INSPECTION 12 November 1980 WEATHER Very windy, cold TEMPERATURE 35° @ 10 A.M.

POOL ELEVATION AT TIME OF INSPECTION 1215.9 feet. M.S.L.

TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL	OWNER REPRESENTATIVES	*OTHERS*
B. M. Mihalcin	None during inspection	
D. J. Spaeder		
K. H. Khilji		

RECORDED BY B. M. Mihalcin

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
SURFACE CRACKS	None observed. Embankment is S-shaped structure.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed. Embankment is well protected by crown vetch. Diversion ditches along entire downstream toe.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good alignment. See "Profile of Dam Crest from Field Survey", Appendix A.
RIPRAP FAILURES	Embankment protected by hard, durable, well graded sandstone. Excellent condition.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Excellent condition.

EMBANKMENT

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
DAMP AREAS IRREGULAR VEGETATION (LUSH OR DEAD PLANTS)	Poor drainage of surface water near downstream embankment at south end of dam causing minor ponding. Not significant, but should be reshaped to drain into diversion ditch.
ANY NOTICEABLE SEEPAGE	None observed.
STAFF GAGE AND RECORDER	None.
DRAINS	None observed.

OUTLET WORKS

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
INTAKE STRUCTURE	Submerged, not observed.
OUTLET CONDUIT (CRACKING AND SPALLING OF CONCRETE SURFACES)	18-inch diameter reinforced concrete pipe. Good condition at outlet end.
OUTLET STRUCTURE	Small concrete endwall - good condition.
OUTLET CHANNEL	Rock (riprap) lined. Good condition.
GATE(S) AND OPERATIONAL EQUIPMENT	Valve wheel visible on riser structure. Not accessible by foot. Owner's representative stated that valve is functional and used to regulate low flow discharge.
MISCELLANEOUS	Riser on outlet structure operates as a drop inlet although its crest is at the same level as the spillway and its capacity is relatively small.

EMERGENCY SPILLWAY

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
TYPE AND CONDITION	Riprap lined, trapezoidal shaped channel with a 12-inch wide, concrete weir wall. Concrete and spillway in good condition.
APPROACH CHANNEL	Riprap lined. Generally unobstructed, but some driftwood in forebay was observed.
SPILLWAY CHANNEL AND SIDEWALLS	Rock lined. Good condition.
STILLING BASIN PLUNGE POOL	None. Spillway channel (centerline) meets outlet channel about 40 feet from outlet conduit headwall.
DISCHARGE CHANNEL	Discharges into natural rock lined channel - no apparent obstruction.
BRIDGE AND PIERS EMERGENCY GATES	None.

SERVICE SPILLWAY

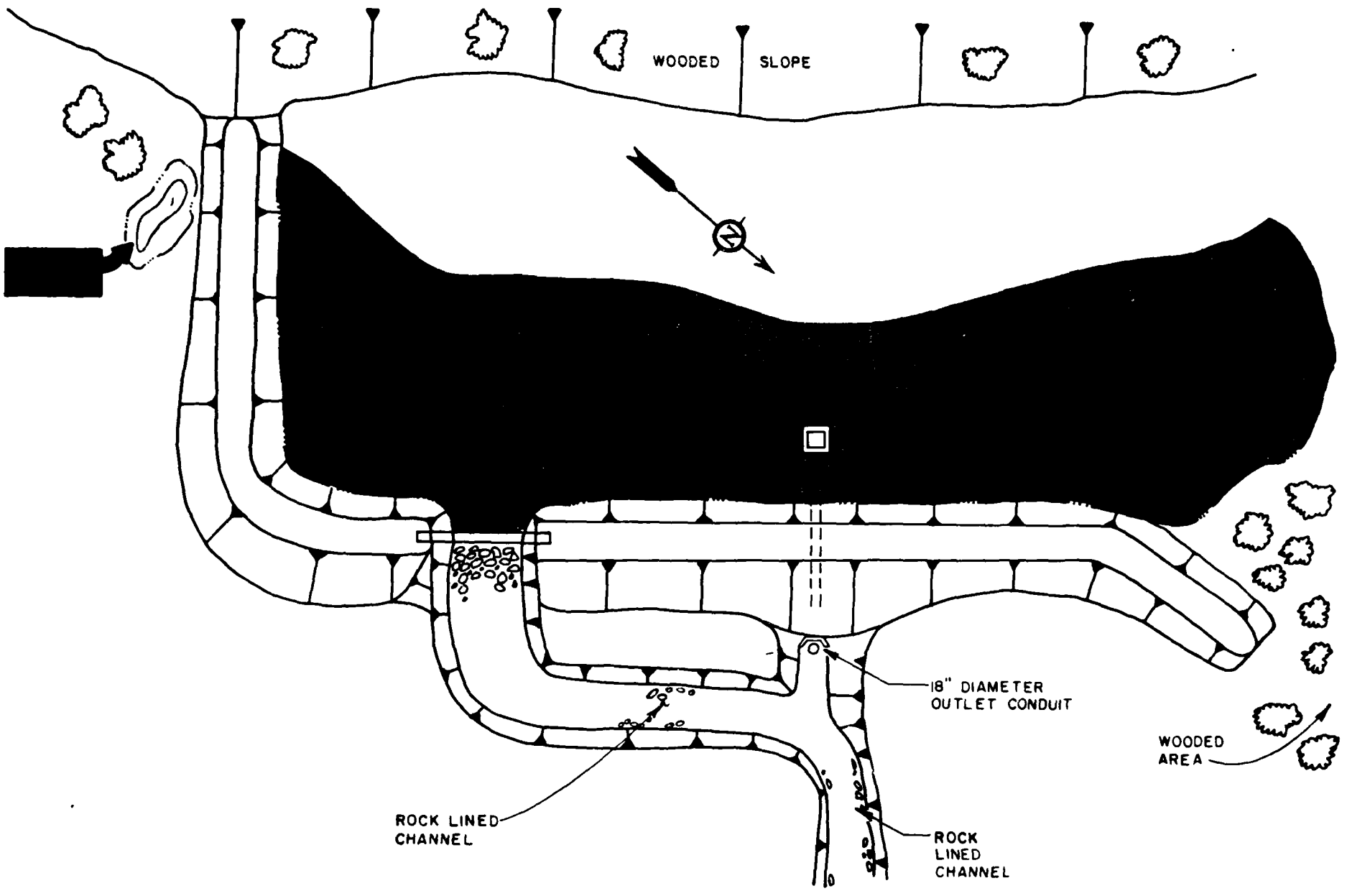
ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
TYPE AND CONDITION	N/A.
APPROACH CHANNEL	N/A.
OUTLET STRUCTURE	N/A.
DISCHARGE CHANNEL	N/A.

INSTRUMENTATION

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
MONUMENTATION SURVEYS	None observed.
OBSERVATION WELLS	None observed.
WEIRS	None observed - although owner's representative reported that a V-notch weir was installed after completion to monitor the flow coming out of the dam. Records were reportedly maintained for a full year, but are no longer available.
PIEZOMETERS	None observed.
OTHERS	N/A.

RESERVOIR AREA AND DOWNSTREAM CHANNEL

ITEM	OBSERVATIONS/REMARKS/RECOMMENDATIONS NDI# PA - 00443
SLOPES: RESERVOIR	Gentle to moderate; partially cleared in immediate lake area but primarily forested.
SEDIMENTATION	Dam constructed at swamp area. Lake level is low and vegetation apparent throughout lake.
DOWNSTREAM CHANNEL (OBSTRUCTIONS, DEBRIS, ETC.)	Stream passes through three local road culverts between embankment and Beaver Lake Lodge Dam.
SLOPES: CHANNEL VALLEY	Steep, narrow and primarily forested valley with steep confining slopes.
APPROXIMATE NUMBER OF HOMES AND POPULATION	Within the reach between Pocono Woodland Lake Dam and Beaver Lake Lodge Dam, located about two miles downstream, it is estimated that as many as ten persons could be affected by the floodwaters resulting from a breach of Pocono Woodland Lake Dam.



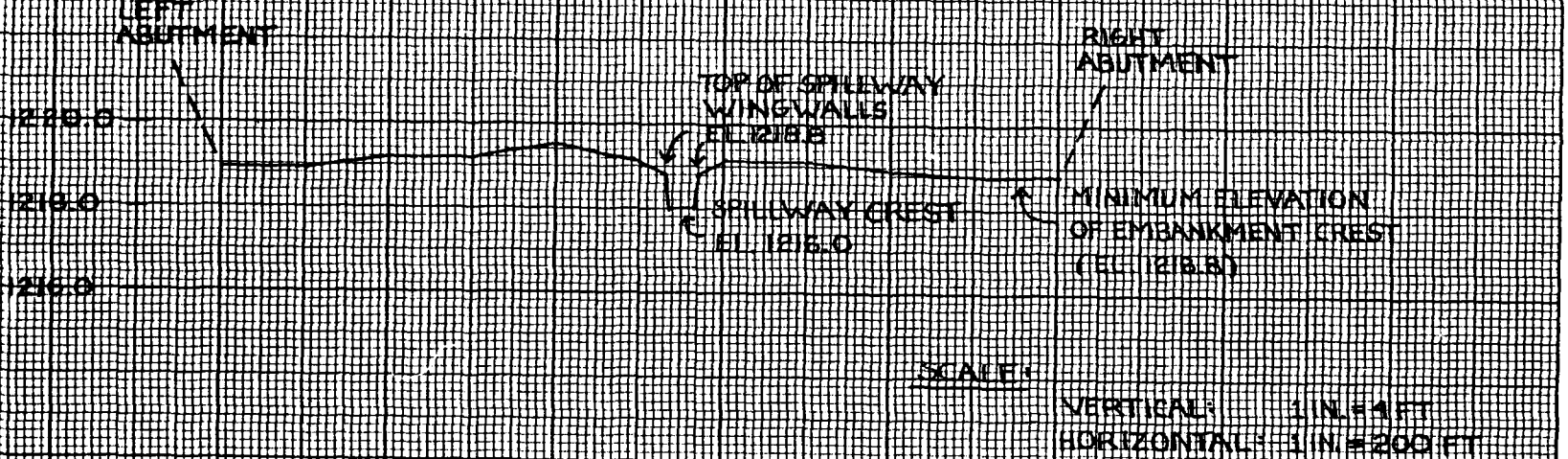
POCONO WOODLAND LAKE DAM

GENERAL PLAN-FIELD INSPECTION NOTES

NDI # PA-00443

POCONO WOODLAND LAKE DAM

PROFILE OF DAM CREST
FROM FIELD SURVEY



SCALE:
VERTICAL: 1 IN. = 4 FT.
HORIZONTAL: 1 IN. = 200 FT.

SUBJECT POCONO WOODLAND LAKE DAM
BY DLS DATE 5-24-81 SHEET NO. OF
CHKD BY JAG DATE 6-30-81 PROJECT NO 80-252-443

APPENDIX B

ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
PHASE I

NAME OF DAM Pocono Woodland Lake Dam

ITEM	REMARKS	NDI# PA - 00443
PERSONS INTERVIEWED AND TITLE	John T. Stieh - Attorney for Pocono Woodland Lake Property Owners Association (Girard Condon, President). Fred C. Schoenagel, Jr., P.E. - Design Engineer (via telephone).	
REGIONAL VICINITY MAP	See Figure 1, Appendix E.	
CONSTRUCTION HISTORY	Dam designed by Fred and Harry Schoenagel (Greentown, PA). Lake geometry (excavation) designed by Bradford, Saivetz & Associates (Braintree, Mass). Facility constructed by G. H. Litz & Sons (East Stroudburg, PA) in 1977. Completed construction in November 1977.	
AVAILABLE DRAWINGS	Two drawings showing lake geometry and details of reservoir excavation (by Bradford, Saivetz & Associates) are contained in PennDER files. "As-built" drawings of dam and appurtenances available from design engineer (see Figures 2, 3 and 4, Appendix E).	
TYPICAL DAM SECTIONS	See Figure 4, Appendix E.	
OUTLETS: PLAN DETAILS DISCHARGE RATINGS	See Figures 3 and 4, Appendix E.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00443
SPILLWAY: PLAN SECTION DETAILS	See Figures 3 and 4, Appendix E.	
OPERATING EQUIP- MENT PLANS AND DETAILS	See Figures 3 and 4, Appendix E.	
DESIGN REPORTS	None available.	
GEOLOGY REPORTS	Erosion control plan by F. Schoenagel (1974) is available in PennDER files and contains discussion of local geology.	
DESIGN COMPUTATIONS: HYDROLOGY AND HYDRAULICS STABILITY ANALYSES SEEPAGE ANALYSES	Design engineer has spillway design calculations designed for C Curve. No stability or seepage study performed.	
MATERIAL INVESTIGATIONS: BORING RECORDS LABORATORY TESTING FIELD TESTING	Test pits dug prior to construction, but no records are available. No testing performed, but, F. C. Schoenagel, Jr., visited site on weekly basis during construction.	

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS NDI# PA - 00443
BORROW SOURCES	Borrow excavated from within reservoir.
POST CONSTRUCTION DAM SURVEYS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
HIGH POOL RECORDS	Not known.
MONITORING SYSTEMS	V-notch weir installed downstream of outlet to regulate required discharge. Readings taken weekly for about one year. Records not available.
MODIFICATIONS	None.

CHECK LIST
ENGINEERING DATA
PHASE I
(CONTINUED)

ITEM	REMARKS	NDI# PA - 00443
PRIOR ACCIDENTS OR FAILURES	None.	
MAINTENANCE: RECORDS MANUAL	None.	
OPERATION: RECORDS MANUAL	None.	
OPERATIONAL PROCEDURES	Self-regulating. Outlet opened sufficiently to provide required discharge in operating permit.	
WARNING SYSTEM AND/OR COMMUNICATION FACILITIES	None. Maintenance personnel visually check dam weekly.	
MISCELLANEOUS	PennDER files contain 17 photographs taken during construction of the dam and excavation of the reservoir area. PennDer files also contain 4 photographs dated April 1978 showing reservoir at normal pool.	

GAI CONSULTANTS, INC.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

NDI ID # PA-00443
PENNDER ID # 52-179

SIZE OF DRAINAGE AREA: 0.32-square mile.

ELEVATION TOP NORMAL POOL: 1216.0 STORAGE CAPACITY: 160 acre-feet.

ELEVATION TOP FLOOD CONTROL POOL: - STORAGE CAPACITY: -

ELEVATION MAXIMUM DESIGN POOL: - STORAGE CAPACITY: -

ELEVATION TOP DAM: 1218.8 STORAGE CAPACITY: 279 acre-feet.

SPILLWAY DATA

CREST ELEVATION: 1216.0 feet.

TYPE: Uncontrolled, trapezoidal shaped channel with 12-inch wide weir.

CREST LENGTH: 30-foot bottom width; 41-foot top width.

CHANNEL LENGTH: 220 feet.

SPILLOVER LOCATION: About 50 feet from south and east embankments junction.

NUMBER AND TYPE OF GATES: None.

OUTLET WORKS

TYPE: 18-inch diameter, reinforced concrete pipe.

LOCATION: Near embankment center.

ENTRANCE INVERTS: 1206.8 (design).

EXIT INVERTS: 1206.3 (field).

EMERGENCY DRAWDOWN FACILITIES: 18-inch diameter sluice gate at inlet.

HYDROMETEOROLOGICAL GAGES

TYPE: None.

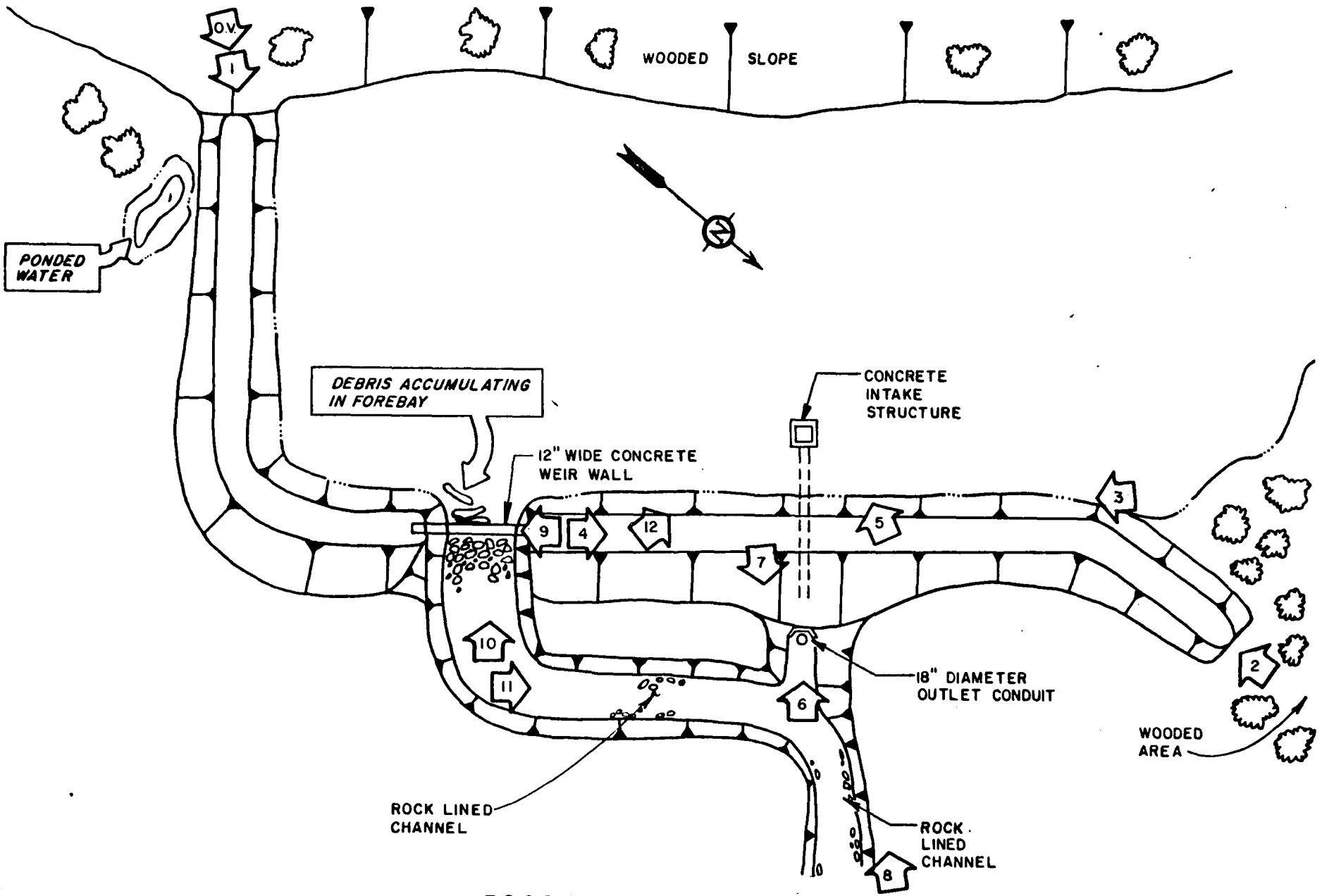
LOCATION: -

RECORDS: -

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX C

PHOTOGRAPHS



POCONO WOODLAND LAKE DAM
PHOTOGRAPH KEY MAP

PHOTOGRAPH 1 Overview of Pocono Woodland Lake Dam as seen from the right abutment.

PHOTOGRAPH 2 View across the embankment crest looking toward the right abutment.

PHOTOGRAPH 3 View of the upstream embankment face looking toward the right abutment.

PHOTOGRAPH 4 View along the embankment crest looking toward the left abutment.

1

2

3

4

PHOTOGRAPH 5 View of the intake structure as seen from the embankment crest.

PHOTOGRAPH 6 View of the discharge end of the outlet conduit.

PHOTOGRAPH 7 View, looking downstream, of the discharge channel immediately below the embankment.

PHOTOGRAPH 8 View looking upstream at the confluence of the spillway (on the left) and outlet conduit (on the right) discharge channels.

5

6

7

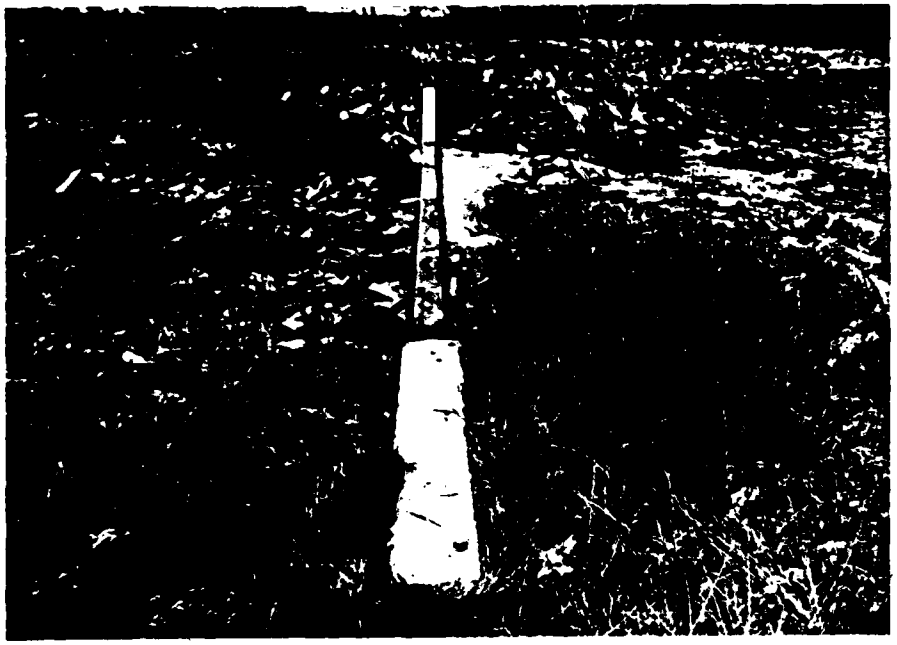
8

PHOTOGRAPH 9 View of the 12-inch wide, concrete, spillway weir wall.

PHOTOGRAPH 10 View of the spillway control looking upstream from the right bank of the spillway channel.

PHOTOGRAPH 11 View of the spillway channel looking downstream.

PHOTOGRAPH 12 View, from the embankment crest, of the lake and surrounding area.



9

10

11

12

APPENDIX D

HYDROLOGIC AND HYDRAULIC ANALYSES

PREFACE

The modified HEC-1 program is capable of performing two basic types of hydrologic analyses: 1) the evaluation of the overtopping potential of the dam; and 2) the estimation of the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. Briefly, the computational procedures typically used in the dam overtopping analysis are as follows:

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

c. Routing of the outflow hydrograph(s) from the reservoir to desired downstream locations. The results provide the peak discharge(s), time(s) of occurrence the peak discharge(s), and the maximum stage(s) of each routed hydrograph at the downstream end of each reach.

The evaluation of the hydrologic-hydraulic consequences resulting from an assumed structural failure (breach) of the dam is typically performed as shown below.

a. Development of an inflow hydrograph(s) to the reservoir.

b. Routing of the inflow hydrograph(s) through the reservoir.

c. Development of a failure hydrograph(s) based on specified breach criteria and normal reservoir outflow.

d. Routing of the failure hydrograph(s) to desired downstream locations. The results provide estimates of the peak discharge(s), time(s) to peak and maximum water surface elevation(s) of failure hydrograph(s) for each location.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: POCONO WOODLAND LAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.0 INCHES/24 HOURS (1)

STATION	1	2	3
STATION DESCRIPTION	POCONO WOODLAND LAKE DAM		
DRAINAGE AREA (SQUARE MILES)	0.32		
CUMULATIVE DRAINAGE AREA (SQUARE MILES)	-		
ADJUSTMENT OF PMF FOR DRAINAGE AREA LOCATION (%) (1)	Zone 1		
6 HOURS	111		
12 HOURS	123		
24 HOURS	133		
48 HOURS	142		
72 HOURS	-		
SNYDER HYDROGRAPH PARAMETERS			
ZONE (2)	1		
C_p (3)	0.45		
C_t (3)	1.23		
L' (MILES) (4)	0.56		
$t_p = C_t (L')^{0.6}$ (HOURS)	0.87		
SPILLWAY DATA			
CREST LENGTH (FEET)	30		
FREEBOARD (FEET)	2.8		

(1) HYDROMETEOROLOGICAL REPORT 33, U.S. ARMY CORPS OF ENGINEERS, 1956.
(2) HYDROLOGIC ZONE DEFINED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT, FOR DETERMINATION OF SNYDER COEFFICIENTS (C_p AND C_t).
(3) SNYDER COEFFICIENTS
(4) L' = LENGTH OF LONGEST WATERCOURSE FROM RESERVOIR INLET TO BASIN DIVIDE.

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY DJS DATE 3-13-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 9-30-81 SHEET NO. 1 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM STATISTICS

HEIGHT OF DAM = 13 FT (FIELD MEASURED: TOP OF DAM TO OUTLET INVERT; "TOP OF DAM" HERE AND ON ALL SUBSEQUENT CALCULATION SHEETS REFERS TO THE MINIMUM ELEVATION ALONG THE EMBANKMENT CREST – SEE "PROFILE OF CREST FROM FIELD SURVEY," APPENDIX A.)

NORMAL POOL STORAGE CAPACITY = 160 AC-FT (SEE NOTE 1)

MAXIMUM POOL STORAGE CAPACITY = 279 AC-FT (@ TOP OF DAM) (HEC-1)

DRAINAGE AREA = 0.32 SQ. MI. (PLANIMETERED ON USGS TOPO QUAD - EDGEMERE, PA)

ELEVATIONS:

TOP OF DAM (DESIGN)	= 1219.0	(FIG 3)
TOP OF DAM (FIELD)	= 1218.8	
NORMAL POOL	= 1216.0	
SPILLWAY CREST	= 1216.0	(FIG. 3)
UPSTREAM INLET INVERT (DESIGN)	= 1206.8	(FIG 4)
DOWNSTREAM OUTLET INVERT (DESIGN)	= 1206.4	(FIG. 4)
DOWNSTREAM OUTLET INVERT (FIELD)	= 1206.3	
STREAMBED @ DAM CENTERLINE	= 1207	(EST, FIG 3)

NOTE 1: OBTAINED FROM "REPORT UPON THE APPLICATION OF THE POCONO WOODLAND LAKES PROPERTY OWNERS ASSOCIATION", TO MAINTAIN AN EXISTING DAM ACROSS AN UNNAMED TRIBUTARY TO RAYMONDSKILL CREEK IN DINGMAN TOWNSHIP, PIKE COUNTY; APRIL 14, 1978; FOUND IN REMINDER FILES.

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY DJS DATE 7-17-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 2 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

DAM CLASSIFICATION

DAM SIZE: SMALL (REF 1, TABLE 1)

HAZARD CLASSIFICATION: HIGH (FIELD OBSERVATION)

REQUIRED SDF: 1/2 PMF TO PMF (REF 1, TABLE 3)

HYDROGRAPH PARAMETERS

LENGTH OF LONGEST WATERCOURSE FROM RESERVOIR INLET TO BASIN DIVIDE: $L' = 0.56$ MILES

(USGS TOPO QUAD – EDGEMERE, PA)

$C_p = 0.45$
$C_t = 1.23$

(SUPPLIED BY C.O.E., ZONE 1, DELAWARE RIVER BASIN)

SNYDER STANDARD LAG: $t_p = C_t (L')^{0.6}$
$= (1.23)(0.56)^{0.6}$
$= 0.87$ HOURS

NOTE: SINCE L_{CA}, THE LENGTH OF THE LONGEST WATERCOURSE FROM THE DAM TO A POINT OPPOSITE THE BASIN CENTROID, IS LESS THAN THE LENGTH OF THE RESERVOIR, THE SNYDER STANDARD LAG IS ESTIMATED AS $t_p = C_t (L')^{0.6}$ HOURS (AS PER C.O.E., BALTIMORE DISTRICT). HYDROGRAPH VARIABLES USED HERE ARE DEFINED IN REF 2, IN SECTION ENTITLED "SNYDER SYNTHETIC UNIT HYDROGRAPH."

SUBJECT DAM SAFETY INSPECTION
Pocono Woodland Lake Dam

BY DJS DATE 3-13-81 PROJ. NO. 80-238-443

CHK'D. BY DLB DATE 4-30-81 SHEET NO. 3 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR CAPACITY

Reservoir Surface Areas:

Surface Area (S.A.) @ normal pool (El. 1216.0) = 39 acres
(planimetered on Fig. 2)

S.A. @ El. 1220.0 = 49 acres
S.A. @ El. 1225.0 = 59 acres
(Planimetered on Fig. 3)

S.A. @ top of dam (El. 1218.8) = 46 acres
(by linear interpolation)

"Zero-Storage" Elevation:

By use of the conic method,
volume @ normal pool = $\frac{1}{3}HA$

where H = maximum depth of reservoir, in ft,
A = surface area @ normal pool = 39 acres

$Vol = \frac{1}{3}HA$

$160 \text{ ac-ft} = \frac{1}{3}H(39 \text{ ac})$

$\therefore H = 12.3 \text{ ft}$

$\therefore$ Zero-storage assumed @ $1216.0 - 12.3 = 1203.7$

Note: Although the minimum reservoir elevation does not necessarily occur at El 1203.7, this value must be used in the HEC-1 input in order to maintain a storage of 160 ac-ft at normal pool.

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY DJS DATE 3-13-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 4 OF 10

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

ELEVATION - STORAGE RELATIONSHIP:

THE ELEVATION-STORAGE RELATIONSHIP IS COMPUTED INTERNALLY IN THE HEC-1 PROGRAM, BY USE OF THE CONIC METHOD, BASED ON THE ELEVATION - SURFACE AREA DATA GIVEN ON SHEET 3 (SEE SUMMARY INPUT/OUTPUT SHEETS).

PMP CALCULATIONS

- APPROXIMATE RAINFALL INDEX = 22 INCHES
  (CORRESPONDING TO A DURATION OF 24 HOURS AND A DRAINAGE AREA OF 200 SQUARE MILES.)
  (REF 3, FIG. 1)

- DEPTH-AREA-DURATION ZONE 1 (REF 3, FIG. 1)

- ASSUME DATA CORRESPONDING TO A 10-SQUARE MILE AREA MAY BE APPLIED TO THIS 0.32 SQUARE MILE BASIN:

DURATION (HRS)	PERCENT OF INDEX RAINFALL
6	111
12	123
24	133
48	142

(REF 3, FIG. 2)

HOD BROOK FACTOR (ADJUSTMENT FOR BASIN SHAPE AND FOR THE LESSER LIKELIHOOD OF A SEVERE STORM CENTERING OVER A SMALL BASIN) FOR A DRAINAGE AREA OF 0.32 SQUARE MILES IS 0.80.
(REF 4, p. 48)

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

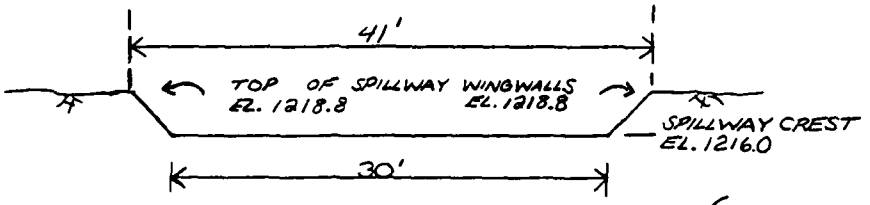
BY DJS DATE 3-16-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 5 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SPILLWAY CAPACITY

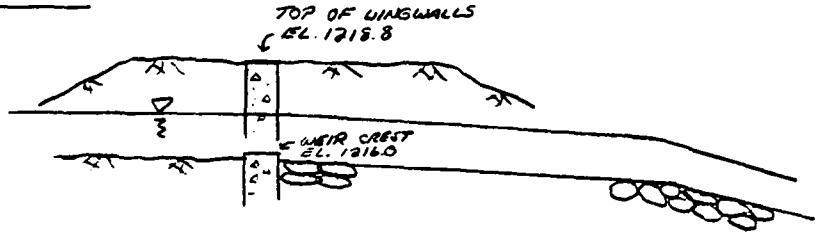
CROSS-SECTION:



(NOT TO SCALE)

(THE DIMENSIONS OF THE DOWNSTREAM SPILLWAY CHANNEL ARE APPROXIMATELY THE SAME AS THAT OF THE WEIR SECTION SKETCHED ABOVE.)

PROFILE:



(NOT TO SCALE)

(SKETCHES BASED ON FIELD MEASUREMENTS AND OBSERVATIONS)

THE SPILLWAY CONSISTS OF A TRAPEZOIDAL-SHAPED RIPRAPPED CHANNEL, WITH AN UPSTREAM CONCRETE CONTROL WEIR, AS SKETCHED ABOVE. IT IS ASSUMED THAT CRITICAL FLOW OCCURS AT THIS WEIR, ALTHOUGH IT MAY ACTUALLY OCCUR AT A POINT A SHORT DISTANCE DOWNSTREAM OF THE WEIR.

ASSUMING THAT CRITICAL FLOW OCCURS AT THE WEIR,

$$\frac{Q^2 T}{g A^3} = 1.0 \qquad \text{(REF 5, p. 8-7)}$$

WHERE Q = DISCHARGE, IN CFS,
T = TOP WIDTH OF FLOW AREA, IN FT,

SUBJECT DAM SAFETY INSPECTION
Pocono Woodland Lake Dam

BY DJS DATE 3-16-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 6 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

AND g = GRAVITATIONAL ACCELERATION CONSTANT = 32.2 FT/SEC^2,
A = FLOW AREA, IN FT^2.

ALSO,

$$Hm = Dc + \frac{Dm}{2}$$

AND $Dm = A/T$ (REF 5, p. 8-8)

WHERE Hm = TOTAL HEAD AT CRITICAL DEPTH, OR MINIMUM SPECIFIC ENERGY, IN FT,
Dc = CRITICAL DEPTH, IN FT,
Dm = MEAN DEPTH OF FLOW AREA, IN FT.

THE RESERVOIR ELEVATION CORRESPONDING TO ANY PARTICULAR DISCHARGE IS THEN $Hm + 1216.0$ (WHERE CREST ELEVATION = 1216.0). THIS IS BASED ON THE ASSUMPTION OF ZERO-VELOCITY HEAD AT THE RESERVOIR JUST UPSTREAM OF THE WEIR, AND NEGLIGIBLE HEAD LOSS TO THE WEIR OR CONTROL SECTION ⇒ NO APPROACH LOSSES. THE SPILLWAY RATING CURVE IS PROVIDED ON SHEET 7.

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY DJS DATE 3-16-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 7 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SPILLWAY RATING TABLE:

D_c (FT)	A ① (FT²)	T ② (FT)	D_m ③ (FT)	H_m ④ (FT)	Q ⑤ (CFS)	RESERVOIR ELEVATION ⑥ (FT)	
0	–	–	–	–	0	1216.0	
0.5	15.5	32.0	0.48	0.7	60	1216.7	
1.0	32.0	33.9	0.94	1.5	180	1217.5	
1.5	49.4	35.9	1.38	2.2	330	1218.2	
1.9	64.1	37.4	1.71	2.8	480	1218.8	(TOP OF DAM)
2.2	75.5	38.6	1.96	3.2	600	1219.2	
2.5	87.3	39.8	2.19	3.6	730	1219.6	
2.8	99.4	41.0	2.42	4.0	880	1220.0	
3.0	107.6	41.0	2.62	4.3	990	1220.3	
3.5	128.1	41.0	3.12	5.1	1280	1221.1	
4.0	148.6	41.0	3.62	5.8	1610	1221.8	
4.2	156.8	41.0	3.82	6.1	1740	1222.1	

① FOR $D_c \leq 2.8$ FT, $A = 30D_c + 1.96 D_c^2$
FOR $D_c \geq 2.8$ FT, $A = 99.4 + (D_c - 2.8)(41)$

② FOR $D_c \leq 2.8$ FT, $T = 30.0 + (3.92) D_c$
FOR $D_c \geq 2.8$ FT, $T = 41.0$

③ $D_m = A/T$

④ $H_m = D_c + D_m/2$

⑤ $Q = \sqrt{g A^3/T}$ (TO NEAREST 10 CFS)

⑥ RESERVOIR ELEVATION = H_m + 1216.0

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY JJS DATE 3-16-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 8 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

EMBANKMENT RATING CURVE

ASSUME THAT THE EMBANKMENT BEHAVES ESSENTIALLY AS A BROAD-CRESTED WEIR WHEN OVERTOPPING OCCURS. THUS, THE DISCHARGE CAN BE ESTIMATED BY THE RELATIONSHIP

$$Q = CLH^{3/2} \qquad \text{(REF 5, p. 5-23)}$$

WHERE Q = DISCHARGE OVER EMBANKMENT, IN CFS,
L = LENGTH OF EMBANKMENT OVERTOPPED, IN FT,
H = HEAD, IN FT; IN THIS CASE IT IS THE AVERAGE "FLOW AREA WEIGHTED HEAD" ABOVE THE LOWEST PORTION OF THE EMBANKMENT CREST, AND
C = COEFFICIENT OF DISCHARGE, DEPENDENT UPON THE HEAD AND THE WEIR BREADTH.

LENGTH OF EMBANKMENT INUNDATED VS. RESERVOIR ELEVATION:

ELEVATION (FT)	LENGTH (FT)
1218.8	0
1218.9	820
1219.0	930
1219.1	540
1219.2	700
1219.3	860
1219.5	990
1219.8	1000
1220.0	1000
1221.0	1050
1222.0	1080

(FROM FIELD SURVEY AND FIG 3;
RT. ABUTMENT SS = 7H:1V
LT. ABUTMENT SS = 33H:1V)

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM

BY JJS DATE 3-17-81 PROJ. NO. 80-238-443

CHKD. BY DLA DATE 4-30-81 SHEET NO. 9 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

ASSUME THAT INCREMENTAL DISCHARGES OVER THE EMBANKMENT FOR SUCCESSIVE RESERVOIR ELEVATIONS ARE APPROXIMATELY TRAPEZOIDAL IN CROSS-SECTIONAL FLOW AREA. THEN ANY INCREMENTAL AREA OF FLOW CAN BE ESTIMATED AS $H_i \times [(L_1+L_2)/2]$, WHERE L_1 = LENGTH OF OVERTOPPED EMBANKMENT AT HIGHER ELEVATION, L_2 = LENGTH AT LOWER ELEVATION, H_i = DIFFERENCE IN ELEVATIONS. THUS, THE TOTAL AVERAGE "FLOW AREA WEIGHTED HEAD" CAN BE ESTIMATED AS H_w = (TOTAL FLOW AREA / L_1).

EMBANKMENT RATING TABLE:

RESERVOIR ELEVATION (FT)	L_1 (FT)	L_2 (FT)	INCREMENTAL HEAD, H_i (FT)	INCREMENTAL FLOW AREA, A_i (FT²) ①	TOTAL FLOW AREA, A_T (FT²)	WEIGHTED HEAD, H_w (FT) ②	H_w/l ③	C ④	Q ⑤ (CFS)
1218.8	0	—	—	—	—	—	—	—	0
1218.9	220	0	0.1	11	11	0.05	0.003	2.90	10
1219.0	430	220	0.1	33	44	0.10	0.01	2.93	40
1219.1	540	430	0.1	49	93	0.17	0.01	2.96	110
1219.2	700	540	0.1	62	155	0.22	0.01	2.98	220
1219.3	860	700	0.1	78	233	0.27	0.02	2.99	360
1219.5	990	860	0.2	185	418	0.42	0.02	3.01	810
1219.8	1000	990	0.3	299	717	0.72	0.04	3.03	1850
1220.0	1000	1000	0.2	200	917	0.92	0.05	3.03	2670
1221.0	1050	1000	1.0	1025	1942	1.8	0.11	3.04	7710
1222.0	1080	1050	1.0	1065	3007	2.8	0.16	3.06	15,480

① $A_i = H_i [(L_1+L_2)/2]$
② $H_w = A_T / L_1$
③ l = BREADTH OF CREST = 17 FT (FIELD MEASURED)
④ $C = f(H_w, l)$; FROM REF 12, FIG. 24.
⑤ $Q = CL_1 H_w^{3/2}$ (TO NEAREST 10 CFS)

SUBJECT DAM SAFETY INSPECTION
Pocono Woodland Lake Dam

BY DJS DATE 3-17-81 PROJ. NO. 80-238-443

CHKD. BY DLB DATE 4-30-81 SHEET NO. 10 OF 10

gai CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

TOTAL FACILITY RATING TABLE

$Q_{TOTAL} = Q_{SPILLWAY} + Q_{EMBANKMENT}$

	RESERVOIR ELEVATION (FT)	① $Q_{SPILLWAY}$ (CFS)	② $Q_{EMBANKMENT}$ (CFS)	Q_{TOTAL} (CFS)
	1216.0	0	–	0
	1216.7	60	–	60
	1217.5	180	–	180
	1218.2	330	–	330
(TOP OF DAM)	1218.8	480	0	480
	1218.9	510 *	10	520
	1219.0	540 *	40	580
	1219.1	570 *	110	680
	1219.2	600	220	820
	1219.3	630 *	360	990
	1219.5	700 *	810	1510
	1219.8	810 *	1850	2660
	1220.0	880	2670	3550
	1221.0	1240 *	7710	8950
	1222.0	1700 *	15,480	17,180

* – LINEARLY INTERPOLATED FROM RATING TABLE, SHEET 7 (TO NEAREST 10 CFS).

① FROM SHEET 7.

② FROM SHEET 9.

SUBJECT DAM SAFETY INSPECTION

Pocono Woodland Lake Dam

BY DJS DATE 3-24-81 PROJ. NO. 80-238-443

CHKD. BY DLG DATE 4-30-81 SHEET NO. 4 OF 6

SUMMARY INPUT/OUTPUT SHEETS

GAI CONSULTANTS, INC.

Engineers • Geologists • Planners
Environmental Specialists

OVERTOPPING ANALYSIS:

```
DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM *** OVERTOPPING ANALYSIS ***
10-MINUTE TIME STEP AND 48-HOUR STORM DURATION

                    JOB SPECIFICATION
  NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
 288       0      10       0       0       0       0       0       0       0
                       JOPER     NWT   LROPT   TRACE
                           5       0       0       0

                MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 1 NRTIO= 5 LRTIO= 1
     RTIOS=     .40     .50     .60     .70    1.00

**********          **********          **********          **********          **********

                              SUB-AREA RUNOFF COMPUTATION

     RESERVOIR INFLOW HYDROGRAPH

                  ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                      1       0       0       0       0       0       1       0       0

                              HYDROGRAPH DATA
     IHYDG    IUNG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
         1       1     .32    0.00     .32    0.00   0.000       0       1       0

                              PRECIP DATA
                    SPFE     PMS      R6     R12     R24     R48     R72     R96
                    0.00   22.00  111.00  123.00  133.00  142.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                                  LOSS DATA
  LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
      0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                          UNIT HYDROGRAPH DATA
                    TP=   .87    CP= .45    NTA= 0

                          RECESSION DATA
                    STRTQ= -1.50    QRCSN=  -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 5.62 AND R= 8.23 INTERVALS

     UNIT HYDROGRAPH 47 END-OF-PERIOD ORDINATES, LAG=    .87 HOURS, CP=  .45  VOL= 1.00
    0.      28.      56.      84.     103.     106.      98.      87.      77.      68.
   60.      53.      47.      42.      37.      33.      29.      26.      23.      20.
   18.      16.      14.      12.      11.      10.       9.       8.       7.       6.
    5.       5.       4.       4.       3.       3.       3.       2.       2.       2.
    2.       1.       1.       1.       1.       1.       1.

                    RAIN    EXCS    LOSS     COMP Q

                SUM 24.99   22.60    2.39    27567.
                  ( 635.)( 574.)(  61.)(  780.61)
```

INITIAL & CONSTANT RAINFALL LOSSES AS PER C.O.E.

BASE FLOW PARAMETERS AS PER C.O.E.

SUBJECT DAM SAFETY INSPECTION
POCONO WOODLAND LAKE DAM
BY JJS DATE 3-24-81 PROJ. NO. 80-238-443
CHKD. BY DLB DATE 1-30-81 SHEET NO. 8 OF 5

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

RESERVOIR INFLOW HYDROGRAPHS

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	500.	292.	94.	48.	13782.
CMS	14.	8.	3.	1.	390.
INCHES		8.49	10.93	11.13	11.13
MM		215.52	277.63	282.67	282.67
AC-FT		145.	186.	190.	190.
THOUS CU M		179.	230.	234.	234.

0.7PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	700.	409.	132.	67.	19294.
CMS	20.	12.	4.	2.	546.
INCHES		11.88	15.30	15.58	15.58
MM		301.73	388.68	395.73	395.73
AC-FT		203.	261.	266.	266.
THOUS CU M		250.	322.	328.	328.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	999.	584.	188.	96.	27563.
CMS	28.	17.	5.	3.	781.
INCHES		16.97	21.86	22.26	22.26
MM		431.04	555.25	565.33	565.33
AC-FT		289.	373.	380.	380.
THOUS CU M		357.	460.	468.	468.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
101	1	0	0	0	0	1	0	0

ROUTING DATA

OLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1216.	-1

STAGE	1216.00	1216.70	1217.50	1218.20	1218.80	1218.90	1219.00	1219.10	1219.20
	1219.50	1219.80	1220.00	1221.00	1222.00				
FLOW	0.00	60.00	180.00	330.00	480.00	520.00	580.00	680.00	820.00
	1510.00	2660.00	3550.00	8950.00	17180.00				
SURFACE AREA=	0.	39.	46.	49.	59.				
CAPACITY=	0.	160.	279.	336.	605.				
ELEVATION=	1204.	1216.	1219.	1220.	1225.				

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1216.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1218.8	0.0	0.0	0.

SUBJECT DAM SAFETY INSPECTION
Pocono Woodland Lake Dam
BY DJS DATE 3-24-81 PROJ. NO. 80-238-443
CHKD. BY RLB DATE 4-30-81 SHEET NO. C OF C

RESERVOIR OUTFLOW HYDROGRAPHS

0.5 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	281.	221.	76.	39.	11145.
CMS	8.	6.	2.	1.	316.
INCHES		6.43	8.87	9.00	9.00
MM		163.21	225.37	228.60	228.60
AC-FT		110.	151.	154.	154.
THOUS CU M		135.	187.	189.	189.

0.7 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	415.	323.	110.	56.	16101.
CMS	12.	9.	3.	2.	456.
INCHES		9.40	12.82	13.00	13.00
MM		238.76	325.72	330.23	330.23
AC-FT		160.	219.	222.	222.
THOUS CU M		198.	270.	274.	274.

PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	726.	487.	163.	83.	23801.
CMS	21.	14.	5.	2.	674.
INCHES		14.15	18.97	19.22	19.22
MM		359.34	481.71	488.16	488.16
AC-FT		241.	324.	328.	328.
THOUS CU M		298.	399.	404.	404.

****

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .40	RATIO 2 .50	RATIO 3 .60	RATIO 4 .70	RATIO 5 1.00
HYDROGRAPH AT	1	.32	1	400.	500.	600.	700.	999.
		(.83)		(11.32)(	14.15)(	16.98)(	19.81)(	28.30)(
ROUTED TO	101	.32	1	214.	281.	347.	415.	726.
		(.83)		(6.07)(	7.95)(	9.82)(	11.76)(	20.55)(

****

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1216.00	1216.00	1218.80
STORAGE	160.	160.	279.
OUTFLOW	0.	0.	480.

OUTFLOW SUMMARY:

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.40	1217.66	0.00	228.	214.	0.00	42.67	0.00
.50	1217.97	0.00	242.	281.	0.00	42.50	0.00
.60	1218.27	0.00	255.	347.	0.00	42.50	0.00
.70	1218.54	0.00	267.	415.	0.00	42.33	0.00
1.00	1219.13	.33	294.	726.	2.83	41.67	0.00

(OVERTOPPING OCCURS @ ≈ 0.76 PMF)

CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

LIST OF REFERENCES

1. "Recommended Guidelines for Safety Inspection of Dams," prepared by Department of the Army, Office of the Chief of Engineers, Washington, D. C. (Appendix D).

2. "Unit Hydrograph Concepts and Calculations," by the U. S. Army, Corps of Engineers, Baltimore District (L-519).

3. "Seasonal Variation of Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours," Hydrometeorological Report No. 33, prepared by J. T. Reidel, J. F. Appleby and R. W. Schloemer, Hydrologic Service Division, Hydrometeorological Section, U. S. Army, Corps of Engineers, Washington, D. C., April 1956.

4. Design of Small Dams, U. S. Department of the Interior, Bureau of Reclamation, Washington, D. C., 1973.

5. Handbook of Hydraulics, H. W. King, and E. F. Brater, McGraw-Hill, Inc., New York, 1963.

6. Standard Handbook for Civil Engineers, F. S. Merritt, McGraw-Hill, Inc., New York, 1963.

7. Open-Channel Hydraulics, V. T. Chow, McGraw-Hill, Inc., New York, 1959.

8. Weir Experiments, Coefficients, and Formulas, R. E. Horton, Water Supply and Irrigation Paper No. 200, Department of the Interior, United States Geological Survey, Washington, D. C., 1907.

9. "Probable Maximum Precipitation, Susquehanna River Drainage Above Harrisburg, Pennsylvania," Hydrometerological Report No. 40, prepared by H. V. Goodyear and J. T. Riedel, Hydrometeorological Branch Office of Hydrology, U. S. Weather Bureau, U. S. Department of Commerce, Washington, D. C., May, 1965.

10. Flood Hydrograph Package (HEC- 1) Dam Safety Version, Hydrologic Engineering Center, U. S. Army, Corps of Engineers, Davis, California, July 1978.

11. "Simulation of Flow Through Broad Crest Navigation Dams with Radial Gates," R. W. Schmitt, U. S. Army, Corps of Engineers, Pittsburgh District.

12. "Hydraulics of Bridge Waterways," BPR, 1970, Discharge Coefficient Based on Criteria for Embankment Shaped Weirs, Figure 24, page 46.

13. Applied Hydraulics in Engineering, H. M. Morris and J. N. Wiggert, Virginia Polytechnic Institute and State University, 2nd Edition, The Ronald Press Company, New York, 1972.

14. Standard Mathematical Tables, 21st Edition, The Chemical Rubber Company, 1973, page 15.

15. Engineering Field Manual, U. S. Department of Agriculture, Soil Conservation Service, 2nd Edition, Washington, D. C., 1969.

16. Water Resources Engineering, R. K. Linsley and J. B. Franzini, McGraw-Hill, Inc., New York, 1972.

17. Engineering for Dams, Volume 2, W. P. Creager, J. D. Justin, J. Hinds, John Wiley & Sons, Inc., New York, 1964.

18. Roughness Characteristics of Natural Channels, H. H. Barnes, Jr., Geological Survey Water-Supply Paper 1849, Department of the Interior, United States Geological Survey, Arlington, Virginia, 1967.

19. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, Bureau of Public Roads, Washington, D. C., 1965.

APPENDIX E

FIGURES

LIST OF FIGURES

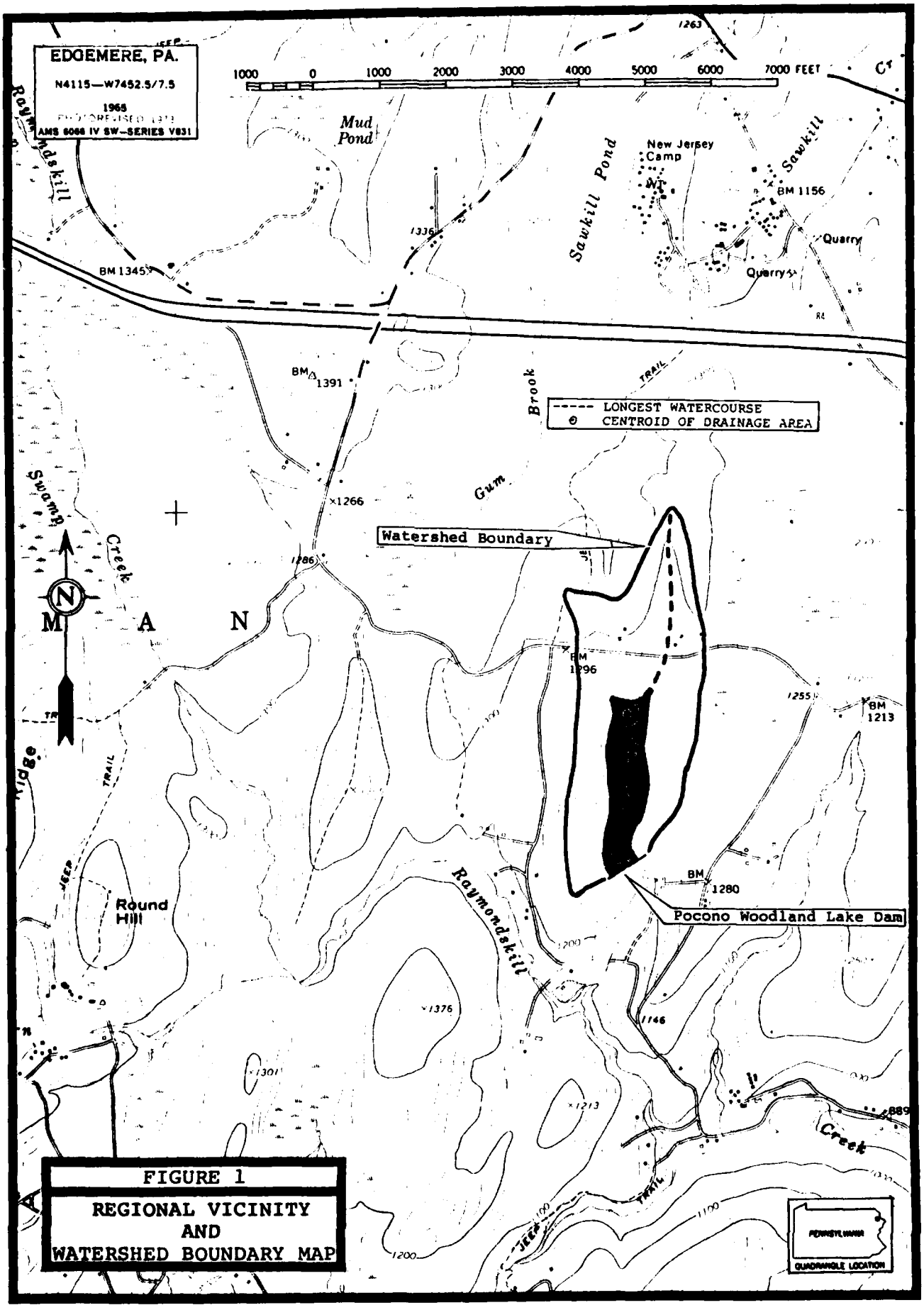
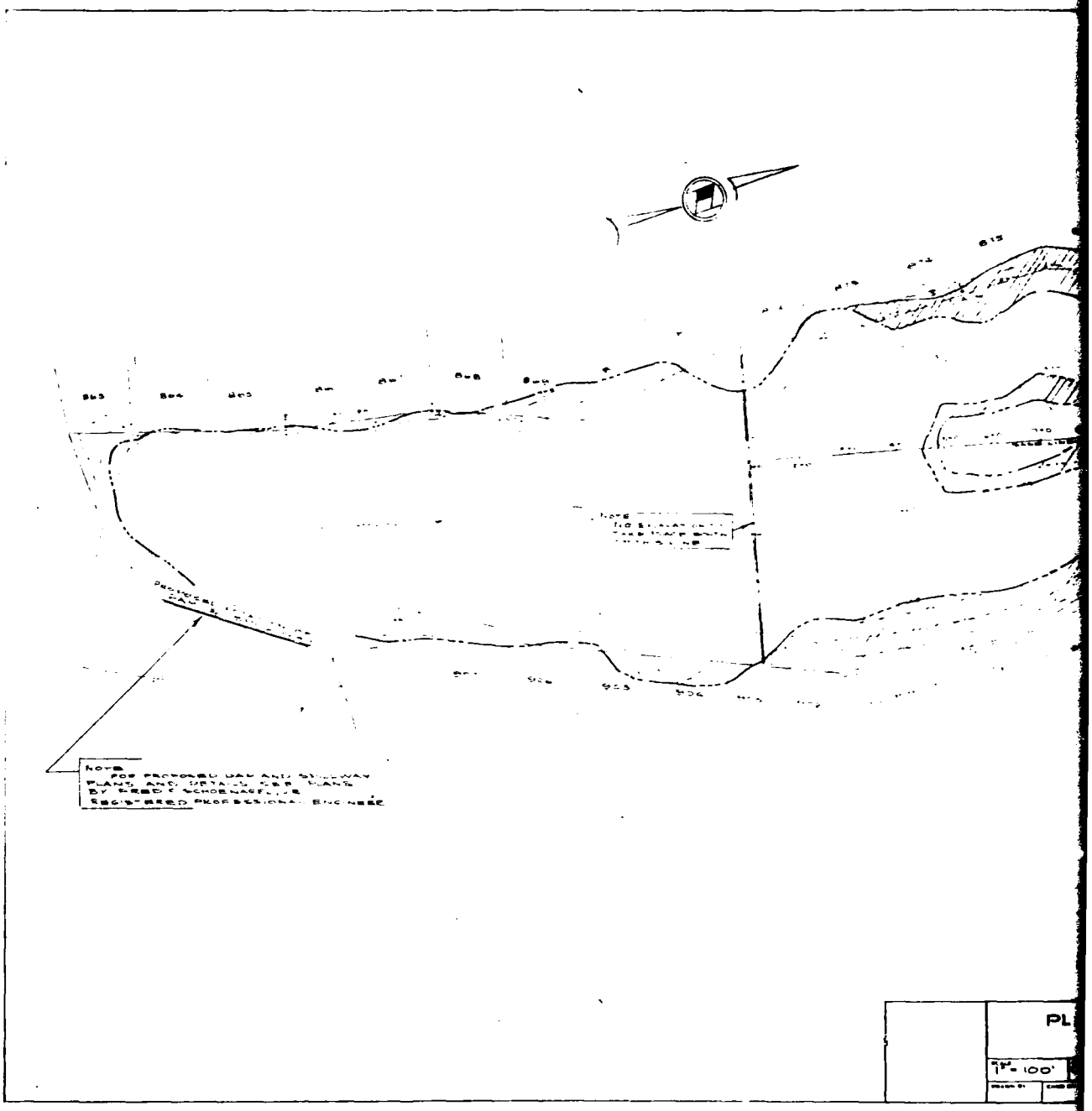


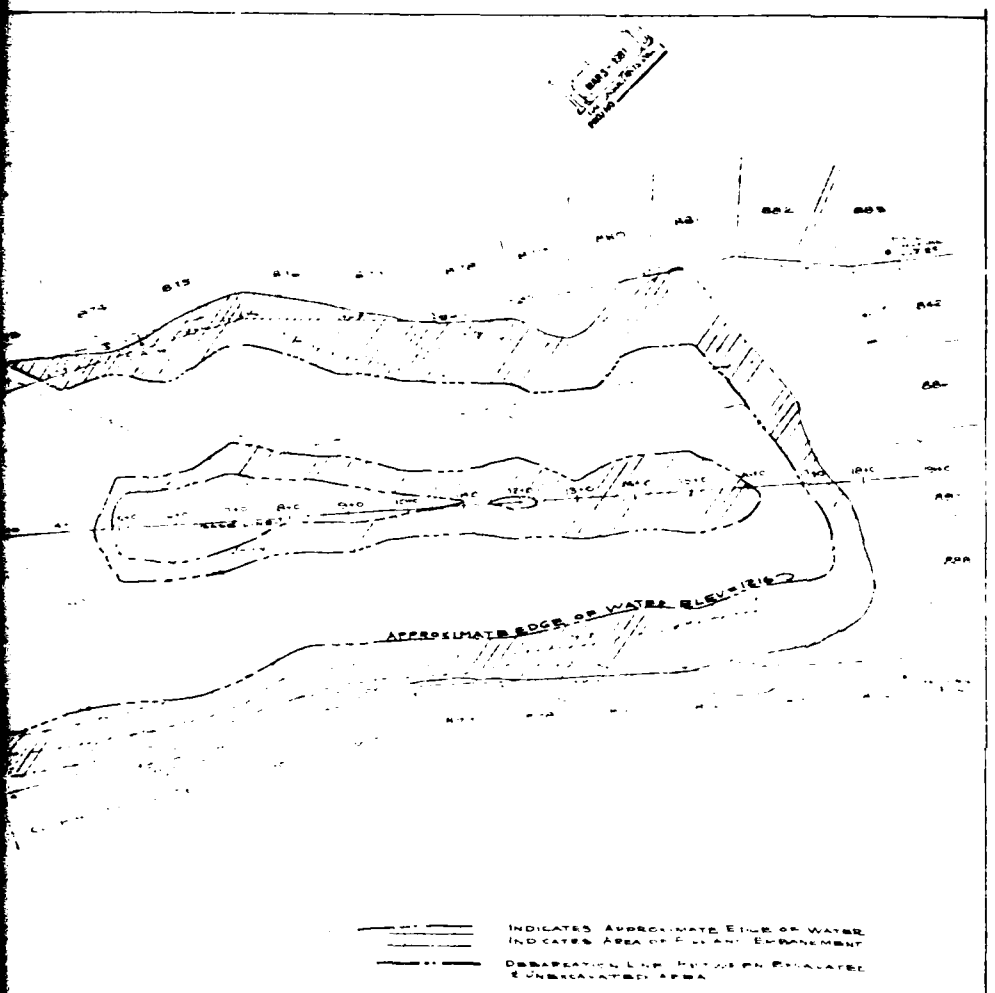
FIGURE 1

REGIONAL VICINITY AND WATERSHED BOUNDARY MAP


PROPOSED DAM & SPILLWAY
NOTE
FOR PROPOSED DAM AND SPILLWAY
PLANS AND DETAILS SEE PLANS
BY FRED C SCHOENAGEL JR
REGISTERED PROFESSIONAL ENGINEER

PL

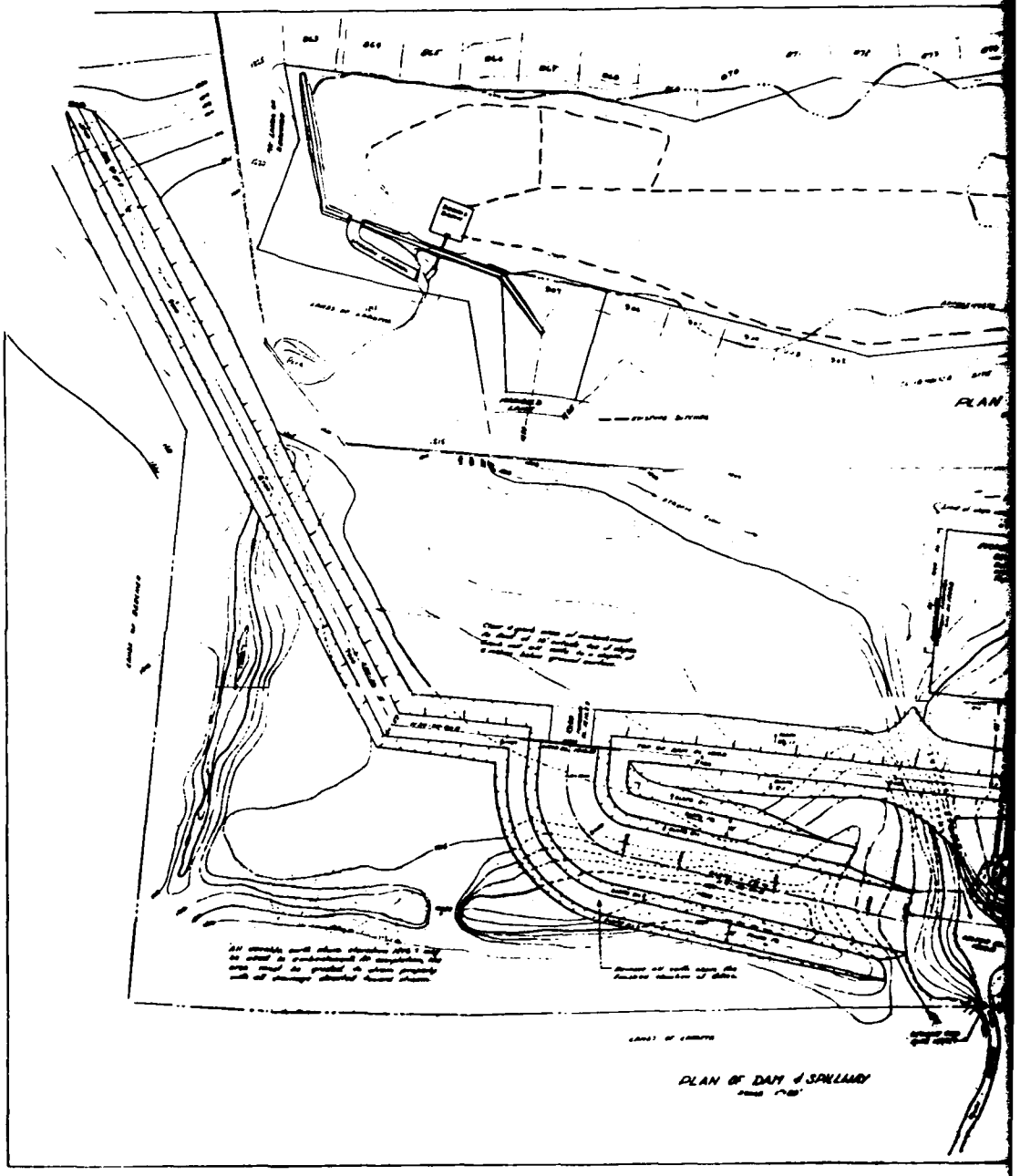
1" = 100'

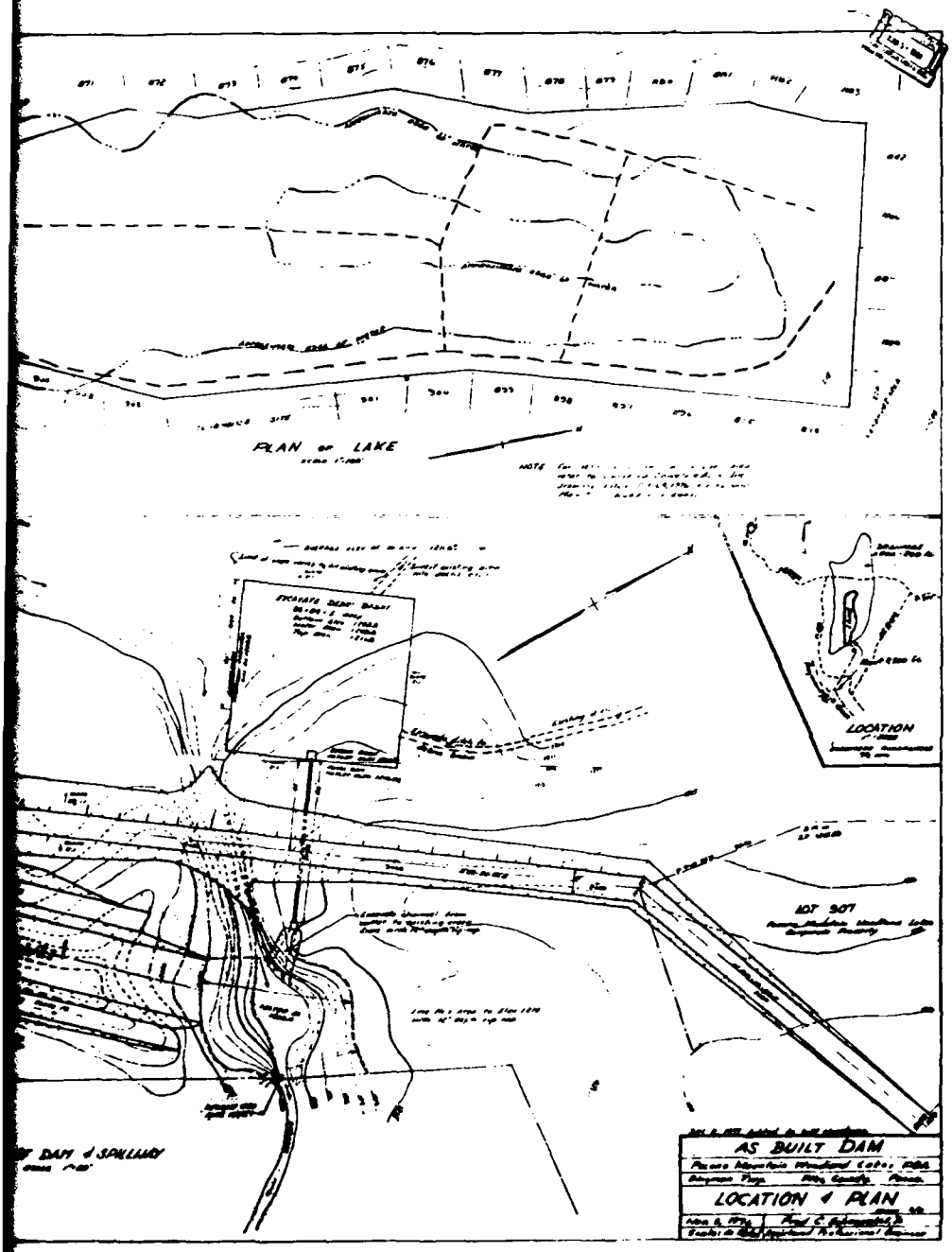


	PLAN OF LAKE		Pocono Mountain Woodland Lakes Dingman Township Pike County, Pennsylvania	SHEET NO. 1
	1" = 100' DATE OCT 28 1976		BRADFORD SAIVETZ & ASSOCIATES INC ENGINEERS AND ARCHITECTS	

GAI CONSULTANTS, INC.

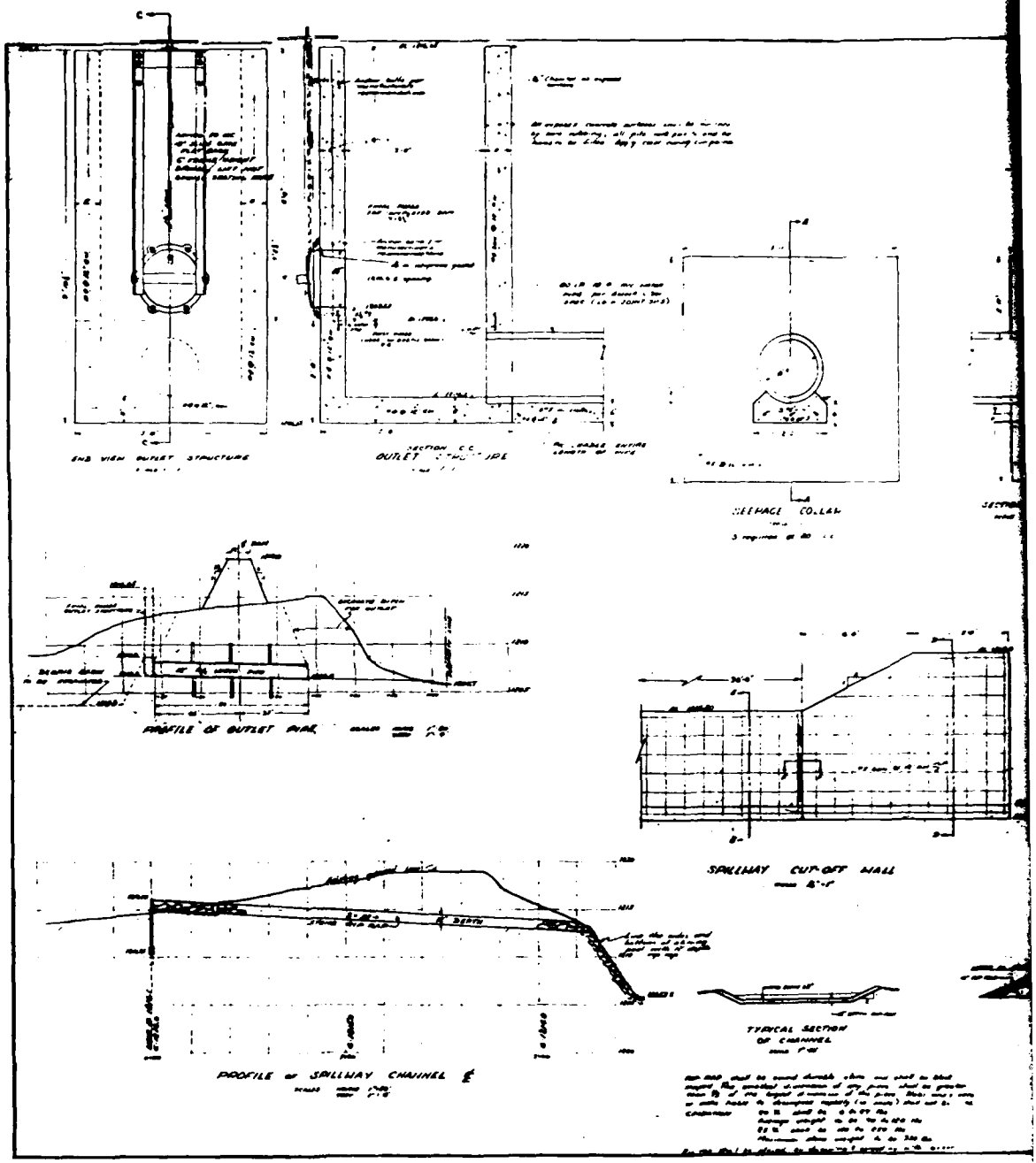
FIGURE 2

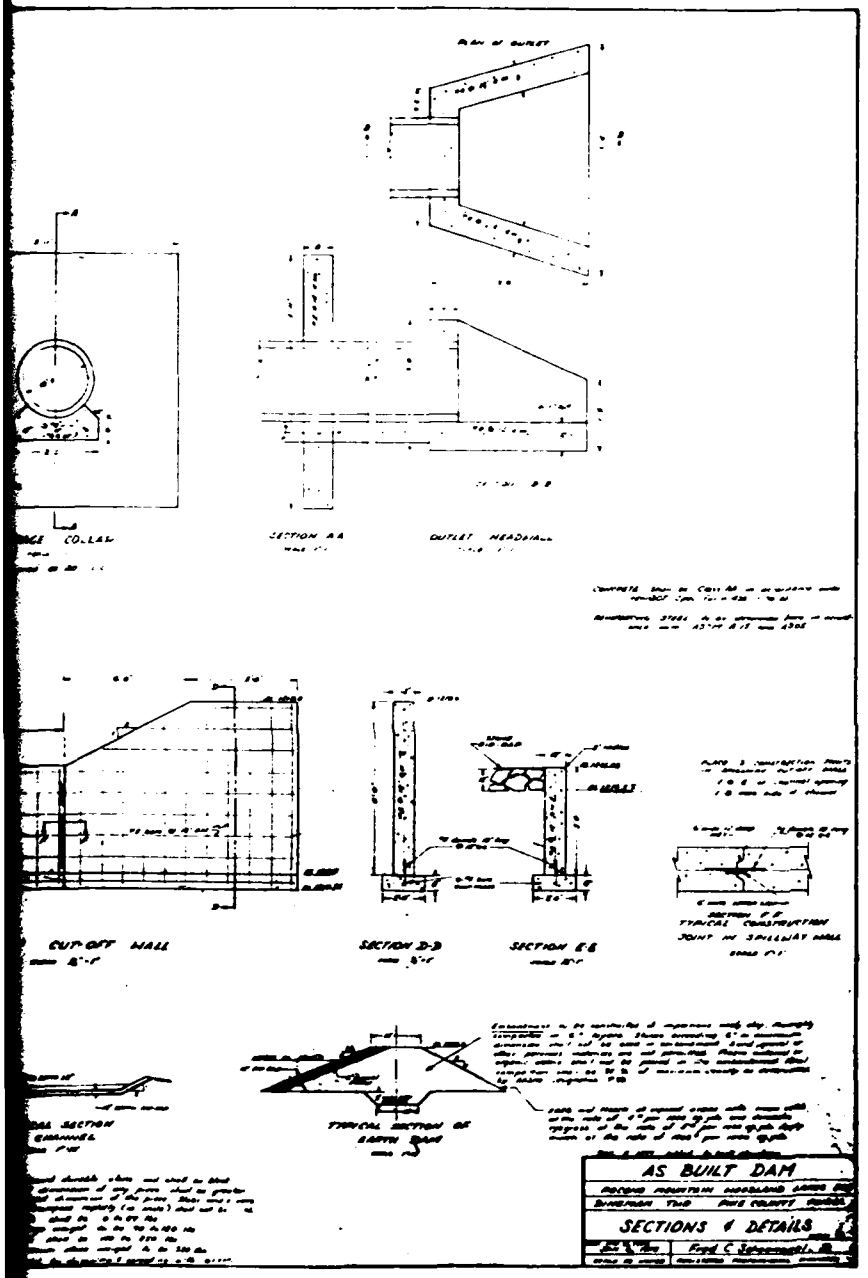

PLAN
PLAN OF DAM & SPILLWAY



gai CONSULTANTS, INC.

FIGURE 3


END VIEW OUTLET STRUCTURE
SECTION C-C
OUTLET PIPE
SEEPAGE COLLAR
PROFILE OF OUTLET PIPE
SPILLWAY CUT-OFF WALL
PROFILE OF SPILLWAY CHANNEL
TYPICAL SECTION OF CHANNEL



GSI CONSULTANTS, INC.

FIGURE 4

APPENDIX F

GEOLOGY

Geology

Pocono Mountain Woodland Lake Dam is located in the glaciated Low Plateaus section of the Appalachian Plateaus physiographic province of eastern Pennsylvania. In this area, the Appalachian Plateaus province is characterized topographically by flat-topped, hummocky hills formed as a result of glaciation and subsequent stream dissection of nearly flat-lying strata. The Devonian age sedimentary rock strata in Pike County regionally strike N35°E and dip gently to the northwest. The Delaware River is the major drainage basin in the area. Major tributary streams intersect the Delaware River at right angles; whereas, smaller streams display a slightly more random tributary pattern. Both major and minor tributary stream systems are joint controlled and exhibit modified rectangular and trellis-type drainage patterns.

Structurally, the area containing Pike County lies on the south flank of a broad, asymmetrical synclinorium that plunges to the southwest. Superimposed on this broad structural basin are numerous anticlinal and synclinal folds characterized by planar limbs and narrow hinges. Due to prior glaciation, low relief and surficial soil cover, fold axes are difficult to trace.

The sedimentary rock sequences in the vicinity of the dam and reservoir are probably members of the Susquehanna Group of Upper Devonian age (see Geology Map). The sedimentological changes observed in the Catskill Formation indicate that the rate of sedimentation exceeded the rate of basin subsidence, resulting in a facies change from marine to non-marine strata. On the accompanying geology map the delineation between the Middle and Upper Devonian age sedimentary rock sequences represents the Allegheny Front, which separates the Valley and Ridge physiographic province from the Appalachian Plateaus physiographic province.

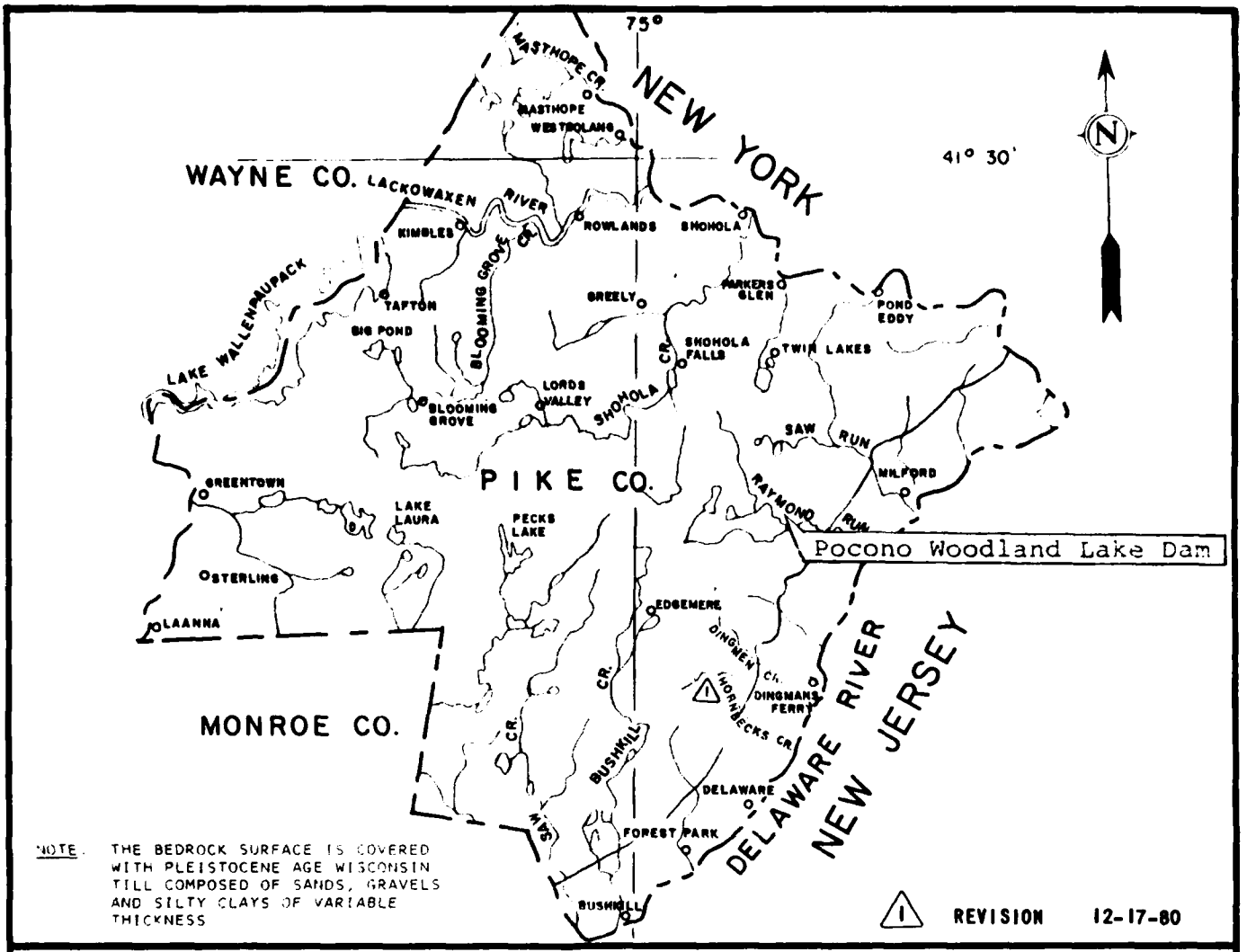
Approximately half of Pike County, including the dam site, is covered by a blanket of Wisconsin age (most recent) glacial drift which, based on the degree of weathering, was probably deposited during the Woodfordian stage. Valley bottoms are typically covered by recent alluvium and Woodfordian outwash of variable thickness, but typically less than 10 feet. These deposits are characteristically unconsolidated stratified sand and gravel, usually with more gravel than sand and some small boulders. The direction of the Wisconsin ice advance was from the northeast over the Catskill Mountains and from the north over the Appalachian Plateau. The terminal moraine resulting from the southern most advance of the Wisconsin ice sheet in this area is located in the southern portion of Monroe County, which borders Pike County to the South.

References:

1. Fletcher, F. W., Woodrow, D. L., "Geology and Economic Resources of the Pennsylvania Portion of the Milford and Port Jervis 15 minute U.S.G.S. Topographic Quadrangles," Pennsylvania Geological Survey, Fourth Series, Harrisburg, Atlas 223, 1970.

2. Sevon, W. D., Berg, T. M., "Geology and Mineral Resources of the Skytop Quadrangle, Monroe and Pike Counties, Pennsylvania", Pennsylvania Geological Survey, Fourth Series, Harrisburg, Atlas 214A., 1978.

3. Sevon, W., Personal Communication, Commonwealth of Pennsylvania Department of Environmental Resources, Harrisburg, December 3, 1980.



NOTE. THE BEDROCK SURFACE IS COVERED WITH PLEISTOCENE AGE WISCONSIN TILL COMPOSED OF SANDS, GRAVELS AND SILTY CLAYS OF VARIABLE THICKNESS

1 REVISION 12-17-80

LEGEND

UPPER DEVONIAN

SUSQUEHANNA GROUP

Catskill Formation - *Shohola Member interbedded 5- to 75-foot thick units of grayish-brown, red-gray-red very fine to medium-grained sandstone and sandy shale and lesser medium-gray to medium-dark-gray siltstone and shale. Sandstones are predominantly low-rank greywackes. Beds are thin to very thick and may have simple or planar sets of small- to medium-scale, generally low-angle cross-stratification. Interbedded with shale units are abruptly disconformable to gradational. Sandstones are typically closely to thinly laminated and well cleaved. Mud cracks, nonplate bedding, and ripple marks are present in some units with sandstone units. Member is more than 2,000 feet thick. Lower contact is gradational and is placed at top of highest red bed of the underlying Analomink. Analomink Member, medium-gray to dark-gray silty, micaceous, finely laminated well-cleaved shale containing thin beds of brownish-gray sandy siltstone and silty very fine grained sandstone. Unit is the "first red" rising up section in Upper Devonian rocks. Member is about 100 feet thick. Lower contact is gradational and is placed at the base of lowest red bed. Delaware River Flags Member, greenish-gray, micaceous, laminated sandstone and lesser amounts of shale. Beds range from a few inches to as much as 4 feet thick. Sandstones are low-rank greywackes and contain no marine fossils. Member is about 500 feet thick. Lower contact is gradational.*

MIDDLE DEVONIAN

HAMILTON GROUP

Mahantango Formation - *Upper member medium-dark-gray, fossiliferous, thin-bedded siltstone, partly shale; member is about 500 feet thick and is separated from lower member by the "Honesdale Reef," a calcareous siltstone biostrome containing abundant horn corals. The Honesdale is about 75 feet thick. Lower member, virtually same lithology as upper member. Unit is about 1,100 feet thick. Lower contact is gradational.*

Marcellus Shale - *Dark-gray, evenly laminated, silty clay shale and clayey silt shale. Unit commonly contains very hard limy concretions and is well cleaved; bedding is generally obscured. Member is about 75-feet thick. Lower contact is gradational.*

SCALE

0 6 12 18 MILES

REFERENCE:
GEOLOGIC MAP OF NORTHEASTERN PENNSYLVANIA. COMPILED BY GEO. W. STOSE AND O.A. LJUNGSTEDT COMMONWEALTH OF PENNSYLVANIA DEPT. OF INTERNAL AFFAIRS DATED 1932, SCALE 1" = 6 MILES.

GEOLOGY MAP

GAI CONSULTANTS, INC.